THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VIII.—No. 189.

THE PHOTOPHONE.

THE discussion on the paper read on the 8th instant before the Society of Telegraph Engineers has gone far to confirm an opinion we expressed in our leading article published in our issue of the 1st November. We there stated that we doubted the accuracy of the conclusions drawn by Professor Bell with reference to the action of light upon matter; and the experiments made by Professor Tyndall seem to have conclusively proved that the effects observed are due to heat and not to light. We do not in the least desire to depreciate the work of Professor Bell; the experiments he has made are in the highest degree interesting and worthy of praise, though the cause of the effects produced may have been misapprehended.

According to Professor Tyndall the sounds produced are probably due to the alternate expansion and contraction of the particles of which the matter is composed under the influence of heat. The experiments are valuable in that they show with what great rapidity changes of temperature may be effected. In the case of the telephone it is shown with what great rapidity magnetic changes can take place.

It is well known that an ordinary electro-magnet takes a comparatively considerable time to become thoroughly magnetised, and an equally long time to become completely demagnetised. Similarly, any kind of matter takes a considerable time to become sensibly heated, and the heat is lost equally slowly. In the two cases we have referred to we have the changes taking place with great and unexpected rapidity. Where the changes are minute the rate of action is correspondingly rapid, and it seems probable that this is so in every physical action; in the case of the action of light upon selenium we have these rapid changes taking place. These facts seem not unlikely to have a considerable bearing upon the question of fast speed working on submarine cables; possibly by signalling by very minute changes in a current a corresponding high speed of transmission may be attained. We do not suggest any means of effecting the object, but we think that there is a field for inquiry in this direction.

MAXIM'S DYNAMO-ELECTRIC MACHINE ARMATURE.

THIS armature, the invention of Mr. Hiram Stevens Maxim, of Brooklyn, America, is shown by figs. 1 to 5.

The body of the armature is constructed of thin plates of iron of the form shown in fig. 4, and at A^2, in fig. 2.

These plates should be of the best annealed iron, and are provided with a series of "lodial" projections which serve as pole extensions. Part of the plates of the armature are made of the form shown in fig. 3, and at B^2, in fig. 2. These are provided with longer projections corresponding to the "lodial" projections of the other plates, and also with additional projections both on the outside and on the inside for the purpose of holding the wire of the coils in position. An armature is constructed by placing a sufficient number of plates alongside of each other, and fastening them together by means of pins or rods, H^2, H^2, made of some diamagnetic material passing through all the plates, as shown in fig. 2. The plates, however, are not placed directly in contact with each other, but are separated by washers upon the rods, H^2, H^2, of about the thickness of the plates, and interposed between them, or between pairs of them, so as to leave air spaces between the plates. Where the tension of the current is very great, as in machines for supplying electric lamps, the larger plates are made of some strong insulating material, a few of them, say, one to each end, and one in the middle being used, and they are made to project so as to keep the wire at some little distance from the iron and prevent all danger of a short circuit.

Where a current of low tension is required, all the rings are made of iron, and it is advantageous under some circumstances to use more of the larger rings, or even to construct the whole armature of them. The manner of winding the coils is shown in figs. 1 and 2, where C^2, C^2, represent the coils wound upon the armature and held in position by the projections on the large plates, B^2, so as to leave air passages between the coils, both upon the inside and upon the outside. The armature is attached to its shaft by means of a hub with spokes fitting into recesses in the rings, or by any other suitable device. It is important, however, that the space between the armature and its shaft should be left substantially open, so as to permit the free ingress of air, and a sufficient number of the plates shown at B^2, having the larger exterior and interior projections, should be used to keep the coils separated throughout their entire course, so as to leave an open passage for air between them. In order to secure the greatest advantages from this construction, the plates composing the armature should be made thin, and a considerable number of them used.

To obviate a sharp bend at the end of the coil, and the consequent injury to the insulation and increase of resistance, the end rings of the cylinder are constructed of half-round iron; this presents an easy curve for the wire at all points.

In other respects than those mentioned, the armature is similar in construction and operation to those which are now well known and in common use.

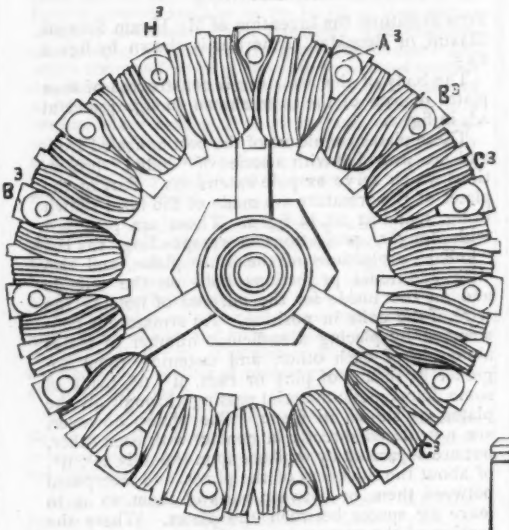


FIG. 2.

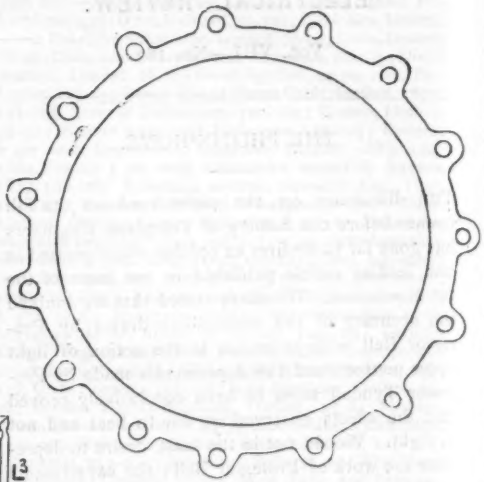


FIG. 4.

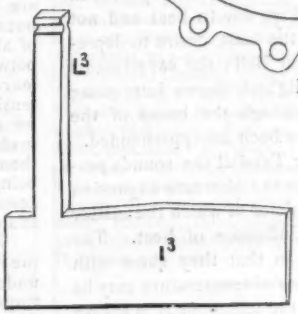


FIG. 6.

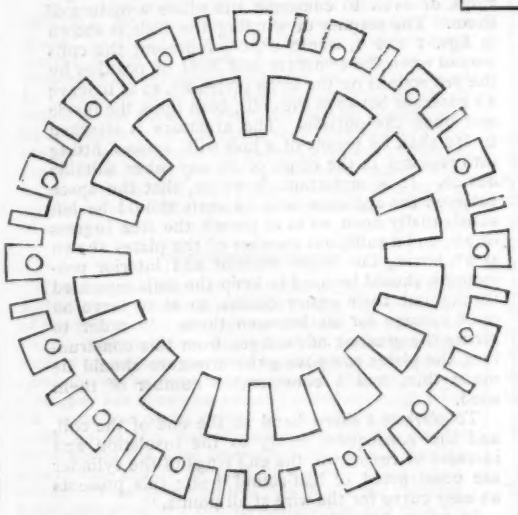


FIG. 3.

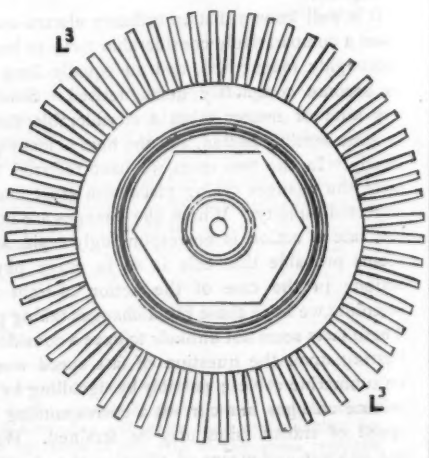


FIG. 5.

The construction of the commutator is best shown in figs. 1, 5, and 6. In fig. 6, one of the metallic plates forming the commutator is shown separately. These plates are made straight upon the edge toward the centre of the commutator-cylinder, but V-shaped upon the side forming the circumference, and each plate is made thicker upon the outside, so that a cross-section would be sector-shaped. The double spiral or V-shaped arrangement of the plates at the circumference is best shown in fig. 1. I^3, I^3, are the metallic plates, and K^3, K^3, are divisions of insulating material between them. Each plate has an arm, L^3, projecting radially, to which the coils are electrically connected in the usual way. As

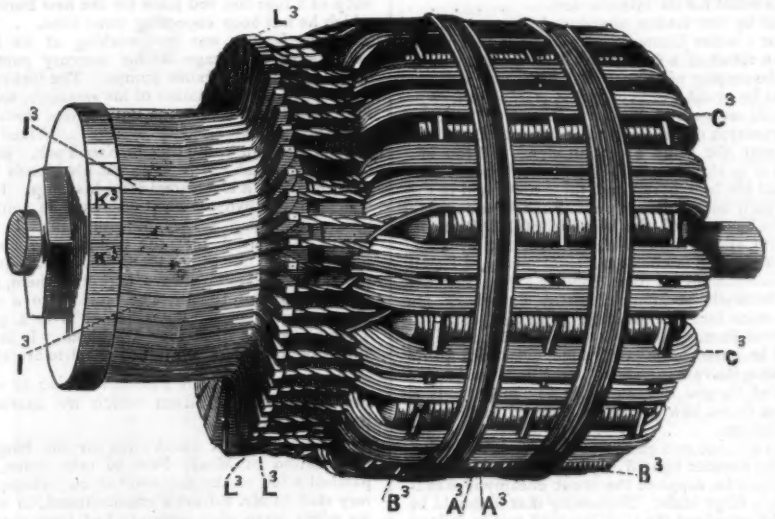


FIG. 1.

the brushes overlap several plates of the commutator when arranged in this way there is no danger of interruption or weakening of the current from the brush leaving one plate before making contact with another, and the plates do not work loose in their clamps or wear unevenly.

THE EDISON ELECTRIC LIGHT.

THE American press in speaking on this subject is so very amusing that we give a few quotations from some well-known papers of that country.

The special correspondence of the *Chicago Tribune* of November 13th contains the following :—

. . . . The visionary dreams of four years ago, the boundless expectations of a sudden and complete revolution in household illumination, and of consequent accession to enormous wealth, have been given up; and the periods of alternate excited hope and strong reaction of a year ago have also come to an end. In their place there are now an intelligent comprehension of the difficulties of electric lighting in households and of the impossibility of obtaining a perfectly durable lamp; and a determination *simply to make the most out of the invention already completed, such as it is.* Last week fully a hundred men worked literally night and day at Edison's shops, in the manufacture of lamps and in the work of experiments; and on Thursday and Friday nights the whole force were up nearly all night making elaborate tests on a scale hitherto never attempted. When I visited the spot Saturday noon, Edison, Bachelor, Upton, and the other principal men, were all still in bed, not having recovered from the fatigues of the previous night. Edison did not make his appearance until about 2 p.m. He then dragged himself out, and came up to the laboratory, looking a little pale and used up, but smiling in spite thereof, because things had gone to his satisfaction.

The lamp now being tried is a slight modification of the vacuum horseshoe carbon lamp. It is not different in principle, but only in form. It is longer and larger. The glass globe is in the form of an elongated lead plummet. It is about six inches long now from the point at the top to the end of the tapering portion below which fits into the chandelier. In the broadest part it is about three inches through. The carbon is a perpendicular loop made by bending double a filament six inches long. The increased length gives increased resistance. The light of the lamp is no longer that of *three* gas burners, but of *one* gas burner; that is to say, of sixteen candle-power. Like all previous lamps of the incandescent class, the light given by it is beyond criticism. It is a gleam of pure and mellow sunlight. It is as lustrous as the morning star. There is no flickering, no dazzling effect, no dark shadows, and little or no heat. Complete purity of the air is preserved, a fact which is now relied upon as one of the strong points giving it commercial value. The carbon is no longer made of the Manilla fibre, as that in last winter's lamp was, but of bamboo, which is found to serve the purpose better. The filament vaporises in

time, just as all its predecessors have done; and the interior of the glass bulbs of lamps which have, in Menlo Park phrase, "busted," is smoked dark with the fumes of the volatilised carbons. But it is believed by Edison that he now has a filament which will last for six months in ordinary use. The Manilla filaments lasted about 700 hours. It is claimed that one of them lasted for 1,700 hours; but only one did that. The bamboo-fibre carbons are expected to stand about 900 or 1,000 hours when perfectly made, or say six months in ordinary practice. This is now the limit of Edison's claim in regard to the matter. On first sight a lamp of such small durability seems of no great value; and, in fact, the probability of a sudden revolution in lighting by means of such an invention seems remote. Nevertheless, Edison believes that the lamp is good enough for use in business houses, and that the time has come to make an effort for its introduction. . . . . Edison has by no means abandoned the search for material for a better filament for carbon. The bamboo carbon is a result of a voyage to China undertaken by a man in the employ of the company, who was sent out to see what he could discover. *A competent scientific gentleman is now about to go to Brazil* to make a thorough research of that region in the interest of the company, with the same object in view. Edison has found that it is the class of plants called endogenous which afford the best fibres, and these are found in the tropics in their best development. For the expedition to Brazil he has secured the services of Mr. Branner, of Cornell College, who was the assistant of Prof. Hart in making the famous geological survey of Brazil for the Government of that country. Mr. Branner made his farewells at Menlo Park on Saturday. He leaves at once for the southern continent, and will begin work at Para. . . . . While the new light is believed to have commercial value, even with all its imperfections, its value *is not so great as to lead to the extinction of the gas companies* by any means. It is not easy yet to see how it can be supplied much more cheaply than gas. . . . . It is ascertained that there are over 1,000,000 gas burners in New York city. The average number lighted nightly is 500,000. Edison's light can be supplied the most cheaply if manufactured on a large scale. Supposing that it should be introduced throughout the city, it would cost as follows per year:—

Coal.—Three pounds per horse-power, giving six lights, 140,000 tons per year, at 3 dollars... ...	420,000 dol.
Labour.—Five men at each central station; twenty at main office; 200 for repairs, inspection, &c., at 20 dollars each per week ...	426,000 "
Lamps.—Three per light per year, at 35 cents	525,000 "
Depreciation, taxation, and repairs—15 per cent. at least—the plant costing 10,000,000 dollars ...	1,500,000 "
Dividends, 8 per cent.	800,000 "
Total ...	3,671,000 dol.

It would thus involve an expenditure of 3,671,000 dollars yearly to produce and maintain 500,000 lights—a moderate estimate, as the probability is that it would go over that sum, as there would be unforeseen expenses in operating a system of such novelty and complexity. The cost per light per year would be 7 dols. 34 cents. The cost per gas-light per year, at rates which companies can afford to concede, varies from 7 dols. 30 cents to 9 dols. 25 cents, according as the consumer is a large or small one. The advantage is in favour of the electric light, but the difference is not what has always been claimed. The claim which Edison used to make, that his lights can be supplied at about 3 dols. per year, is utterly unfounded. The above calculation is not altogether novel to men engaged in the manufacture of gas, but there are many private citizens holding gas-shares, but having no connection with the practical part of that industry, who might be thrown into sudden and unnecessary alarm were they not warned beforehand about the cost of the electric light, and against the demonstration about to be made at Menlo Park.

The *New York Herald* of November 18th says:—

A visit to Menlo Park found the unwearying Edison cheerily superintending the entry into his workshop of a four-ton bed plate for the new Porter engine, which he has been expecting some time. . . . . The new factory was not working at its full force because of a leakage in his mercury pump, which supplied the 500 vacuum pumps. The leakage caused the salivation of a number of his *employés*, and obliged him to suspend operations until a new mercury-tight pump was procured. . . . . Asked about the Maxim lamp on exhibition in New York. Mr. Edison said that he had not seen it, but his friends had. He thought it was a clean steal from his lamp. He did not believe in the hydro-carbon vacuum; he smiled at the idea of plugging a vacuum with wax. It would be found, he believed, that the globes were fused at the point. "I do not worry about them, or a hundred like them," he said; "I always expected them, and there will be more of them. The lamp is to a system of electric lighting what a gas-burner is to a gas works. They know just what they are about. It is simply a stock-jobbing operation to float electric arc stock."

Puck, the American *Punch*, has also an article on the same subject, from which we extract a few paragraphs:—

As we thought it about time for the long-deferred illumination of Menlo Park to take place, we despatched a few of the members of our artistic and literary staff to Mr. Edison's establishment, in order that we might learn what progress had been made in Mr. Edison's experiments.

Mr. Edison received the *Puck* delegation with much cordiality, and, as he was busily engaged at the moment in perfecting the "Panto-Debagulator"—a machine for preventing trousers from bagging at the knees—he desired to be excused for a short period, but requested that the gentlemen would make themselves quite at home and look over the works as they pleased. He would afterwards join the party and explain anything that might not be clearly understood.

Mr. Edison afterwards explained that he had entirely rejected carbon points for the electric light. He had discovered that there was nothing equal to a tallow candle wick, provided it had a full supply of tallow encircling it. Experience had also taught him that an old-fashioned tin candlestick was the best kind of receptacle for the tallow candle.

On the topic of the electric railway it also says that—

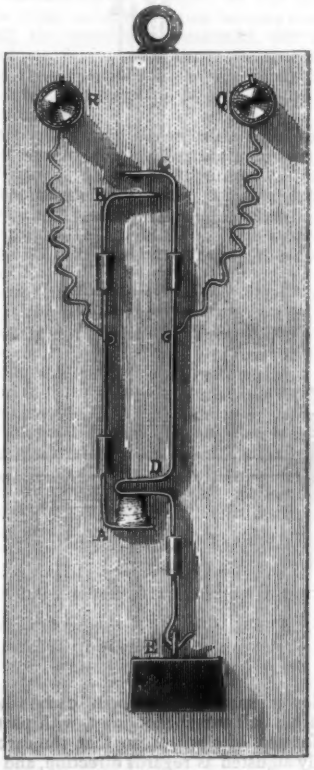
Mr. Edison had found that batteries and other paraphernalia that are usually associated with electric locomotors take up too much space. How was this obstacle to be surmounted? Many long nights and weary days did Mr. Edison ponder over this problem. Sometimes it appeared as though he had solved it—at others as if its solution was further away than ever. He had almost given up the subject in despair when a

sudden light burst upon him. Why not substitute for artificial generation of electricity, *Human Electricity?*

By putting a human being at the cast-iron crank, the needed motive power is supplied, and thus for the first time in the history of the world human electricity, combined with elbow grease, is utilised.

ELECTRIC FIRE ALARM.

A LARGE number of arrangements have been invented for announcing the presence of a fire by means of an electric bell set in action as soon as the temperature of the place where it is set has become raised above its normal degree. One well-known piece of apparatus consists of a simple



thermometer tube with mercury; when the latter expands by an elevation of temperature it completes the circuit with a platinum wire connected to a battery, and thus sets the bell in action.

M. C. Dupré has constructed, at M. Duboscq's residence, an apparatus based on the same principle, but the arrangement of which is new and original.

Two metallic tongues, A B, C D, are connected in the circuit of the battery and electric bell by the intervention of the buttons, R and Q. The tongue, C D, is separated from the first tongue, A B, which is fixed, by a small mass of tallow placed on the lower of the two tongues (*see* figure). If the temperature becomes raised by reason of a fire occurring, the tallow melts, the tongue, C D, drops under the influence of the weight, E, and comes in contact with the tongue, A B; the circuit is established, as explained above, with the upper part of the system, and the bell rings.—*La Nature.*

NEW ELECTRIC LAMPS.

MAXIM'S ARC LAMP.

THE chief peculiarities in the new lamp consist in an improved method of regulating the feeding mechanism, and in an improved construction of the part of the lamp carrying the lower carbon and the globe.

In electric lamps as usually made Mr. Maxim considers that the regulator is not sufficiently sensitive, as it requires too great a change in the strength of the current to cause it to act, and this has been the cause of unsteadiness in the light. In order to obviate this difficulty all friction is removed from the regulating device by suspending the working parts upon springs, which at the same time support the upper carbon and its feeding mechanism free from contact with all other parts of the lamp, and serve as frictionless conductors of the current to the carbon-holder.

Lamps as hitherto constructed have also been subject to another difficulty. It is frequently necessary to remove the globe in order to perfectly adjust the carbons when they are first put in, and in such lamps no means have been hitherto provided for setting or removing the globe when the carbons are of full length and adjusted without disturbing their adjustment. To obviate this difficulty the side rods which carry the globe-holder are made telescopic.

Fig. 1 is a front elevation and fig. 2 a side elevation of the new lamp. Fig. 3 (drawn to an enlarged scale) is partly an elevation and partly a central vertical section of the upper part of the same, showing the feeding mechanism and regulator.

A is the case containing the feeding mechanism and regulator; B is an axial magnet or coil, and C the iron core of the same; D is a brass extension of the magnet-core screwed into its upper end, and extending some distance above it.

This extension, D, carries the train of clock-work, E, which is of the usual form used in such lamps, and the magnet-core and its extension are suspended upon the springs, T, T^1, and I. F is a star wheel mounted upon the most rapidly moving shaft, and carrying one or more fans; G is a stationary detent affixed to the case, A; H is a controlling clamp or dash-pot connected with the magnet-core and its extension to prevent the too rapid movement of the parts. The perpendicular spiral spring, I, is hung upon the two adjusting screws, J and K. The nut of the screw, K, has a fan-shaped projection bearing loosely against the side of the case to keep the spring from turning.

The screw, K, is attached to the case, A, and the screw, J, is attached to a projecting arm, S, of the

magnet-core, so that the spring, I, tends to support the core with its extension and connected mechanism, and the tension of the spring may be readily adjusted either from above or below. L is a combined hook and lever pivotted to the case, A, and fitted to hook over the projection, S, and thus hold up the parts connected therewith. This hook is provided with a lever-handle for convenience of manipulation, and has a spring, R, bearing upon it like the back spring of a knife, and so arranged that the lever has two positions of rest—that is to say, one when the hook is thrown forward and one when it is thrown back. N is the positive binding screw, and O is the negative binding screw. The

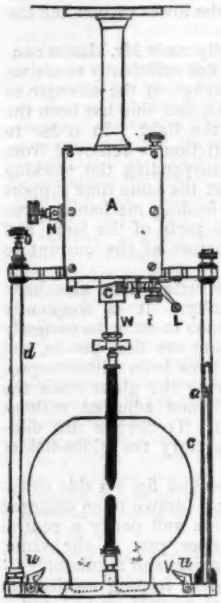


FIG. 1.

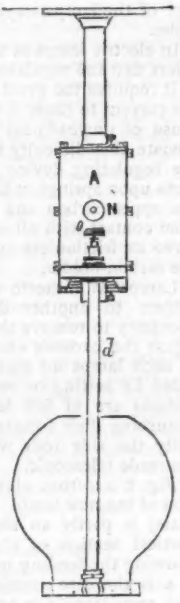


FIG. 2.

positive wire is carried from the interior end of the screw, N, to the coil of the magnet, B, and passes thence to the case, A, from which it is conveyed to the upper carbon-holder. A metallic spring is attached to the core extension, and presses lightly upon the inclosed spindle to insure perfect electrical connection between the parts.

The binding screw, O, is electrically connected with the lower carbon-holder by the side rod, *d*, and the globe-holder, X. P and Q are set screws to limit the vertical movement of the magnet-core and its connected parts. The flat, horizontal springs, T, T^1, are attached at one end to the case, A, and at the other to the projections, S, S^1, affixed to the magnet-core and its extensions. The side rods, *d*, *d*, are attached to the case, A, with a joint of insulating material, and support the globe-holder, X. These rods are made hollow, and other rods rigidly attached to the globe-holder are inserted in them longitudinally. This construction is shown in fig. I, where the rod, *d*, is represented partially in section. *c* is the interior rod, and *a* is a head attached to it to bear against an interior shoulder at the lower end of the tube, *d*, and prevent an entire separation of the parts. U, U, are short projections on the rods, *d*, *d*, bevelled on their lower sides, and V, V, are spring-catches, which are hinged to the globe-holder, and which hook over the projections, U, U, and hold the globe-holder up.

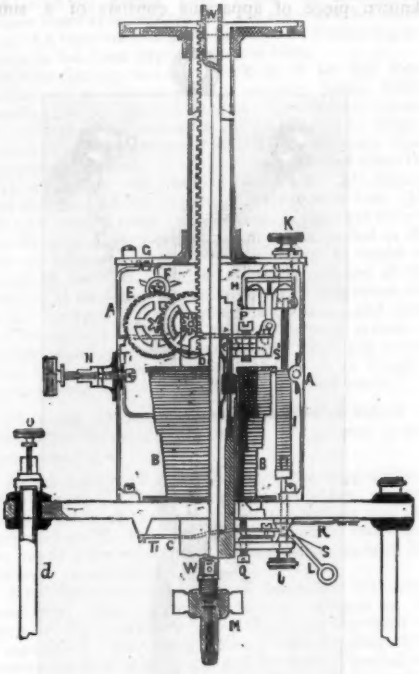


FIG. 3.

The lower part of the upper carbon-holder is made with a ball and socket joint, with part of the socket formed of a nut, M, so that the carbon may be readily adjusted as regards direction, and secured firmly in position by turning the nut. The upper carbon-holder is carried by a spindle, W, passing longitudinally through the magnet-core and its extension. This spindle has a rack on one side, which engages with a small pinion of the train of clock-work on the shaft having the slowest movement, but otherwise is free to move longitudinally.

The operation of the lamp is as follows:—The magnet-core, C, and its extension, D, have a free vertical motion within the coil, B, and are suspended upon the horizontal, flat springs, T, T^1, and the spiral spring, I, as above stated; and as the magnet-core

is located somewhat lower down than its coil, it constantly tends to rise when the coil is excited by a current of electricity. The spindle, W, is supported by the train of clock-work only, and its weight is so adjusted that it will descend slowly when the gearing is free to move. The tension of the supporting springs is so adjusted to the weight of the magnet-core and the parts which it carries that the train of gearing shall hang just low enough to clear the detent, G, when a current of ordinary strength is passing. The gearing then slowly turns, and the spindle, W, descends, bringing the carbons together to supply the consumption at the focus.

If the points approach too closely to each other, the current increases in strength, the magnet-core is drawn in, the upper carbon is retracted, and the feeding mechanism is arrested by the detent, G. If, on the other hand, the points become too widely separated, the current is weakened, the magnet-coil loses its power, and the core descends and advances the upper carbon; at the same time the gearing is released from the detent, and the feeding process proceeds.

The apparatus may be adjusted with very great nicety by means of the adjusting screws, J and K, and the spring, I; and as the moving parts are freely suspended, and nicely balanced upon the supporting springs, a very slight change in the current passing through the coil is sufficient to bring the gearing into contact with the detent or to release it.

Whenever it is desired to stop the light, the hook, L, is sprung over the arm, S, and the feeding mechanism is by one operation retracted and locked.

Whenever it is necessary to renew the carbons, the spindle, W, is pushed up (a ratchet in the gearing allowing it to move upward freely), and the globe is removed. When the new carbons are adjusted to position, the globe-holder is depressed by pressing down the catches, V, V, and drawing out the telescopic side rods, the globe is replaced over the lower carbon, and the globe-holder returned to its former position without disturbing the adjustment of the carbons.

KRIZIK AND PIETTE'S ARC LAMP.

THIS lamp effects automatically the regulation of the distance of the carbons without the aid of clockwork or other like mechanism, by the use of solenoids having special cores, such solenoids and cores being applicable where, as in electric lamps, uniformity of attractive force has to be maintained throughout a considerable length of stroke. Two solenoid coils are placed end to end, with their axes in the same straight line, and with one iron core free to slide lengthwise within both, this core carrying at its end one of the carbons of the lamp, and being balanced when it is vertical, or running on rollers when it is horizontal. The one solenoid coil of low resistance is in the lamp circuit; the other of high resistance is in a branch circuit connecting the conductors to and from the lamp. The core is so shaped that so long as the two solenoids exert equal attractive forces it remains stationary, notwithstanding that it may have been previously moved lengthwise, so as to extend farther into or through the one coil than the other; and in order that it may have this property it is made with the mass of its metal reduced towards the ends. This may be done either by tapering it from the middle of its length to a less diameter at each end, or by boring it from each end with a tapering bore; or, instead of giving the metal a regular taper externally or internally, its diameter or thickness may be reduced by steps from the middle each way. Or it may be made of a number of pieces of iron rod or tube united end to end, with pieces of non-magnetic material of different lengths intervening between the lengths of iron. The core so constructed, carrying one of the carbons, will then adjust itself, moving the one carbon to or from the other, until the attractive forces exerted on the core by the two solenoids in opposite directions become balanced. When the carbons are too near the resistance of the arc is so far lessened that the solenoid in the circuit of the carbons becomes the more powerful of the two, and the core thereupon moves so as to separate the carbons. When, on the other hand, the carbons are too far apart, the resistance of the arc is so much augmented that the solenoid in the circuit of the carbons becomes the weaker, and the core thereupon moves so as to bring the carbons nearer together. According to a modified arrangement, when it is desired to retain the voltaic arc in one position, each of the carbon holders has attached to it a half taper, or stepped core, such as has been described above, each half core being free to move longitudinally within one of the solenoids; and the carbon holders are connected together in the usual way by gearing, so as to move in opposite directions through spaces proportioned to the relative rates of consumption of the two carbons. It is of advantage to combine with the lamp an automatic shunt of any known construction, so that when the lamp is extinguished the current is shunted into the general circuit.

Figs. 1, 2, 3, and 4, show the principles on which the new lamp is founded. If an iron core of uniform section, as shown in fig. 1, be placed within two solenoid coils, S and S^1, of equal magnetic force, the attraction on the core will depend on its position relatively to the coils; it is strongest when one end of the core is in the middle of the coil, and weakest when the middle of the core is in the middle of the coil. Hence, when the core is in the position shown in fig. 1, it will be more strongly attracted by S^1 than by S. When, however, the mass of the core at different parts of its length varies, the attraction of the two coils upon it may be equalised. Thus, by making the core in the form of a double cone, as shown in figs. 2, 3, and 4, notwithstanding the different positions occupied by the core, it remains equally attracted by the two coils, S, S^1, figs. 2 and 4 showing its extreme positions each way, and fig. 3 its middle position. The core, instead of being truly tapered towards each end, may be reduced by steps, as indicated in fig. 5; or it may be hollowed out by tapering holes, as in fig. 6; or it may be made up of a number of separate lengths of iron connected together by non-magnetic material, as indicated in fig. 7; and these lengths may be bored through with holes of different diameter, as indicated in fig. 8. By thus constructing the cores they may be made to move over considerable distances without under-

FIG. 1.

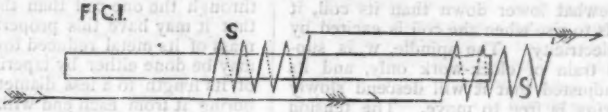


FIG. 2.

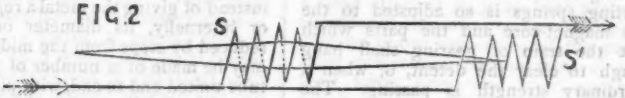
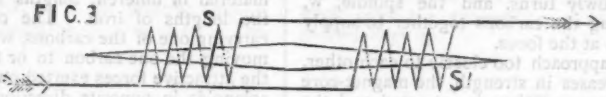


FIG. 3.



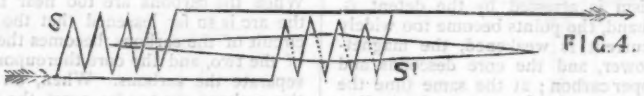


FIG. 4.

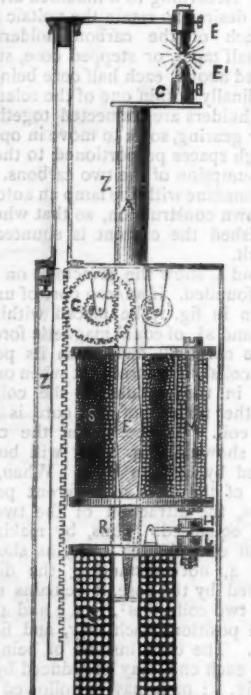


FIG. 11.

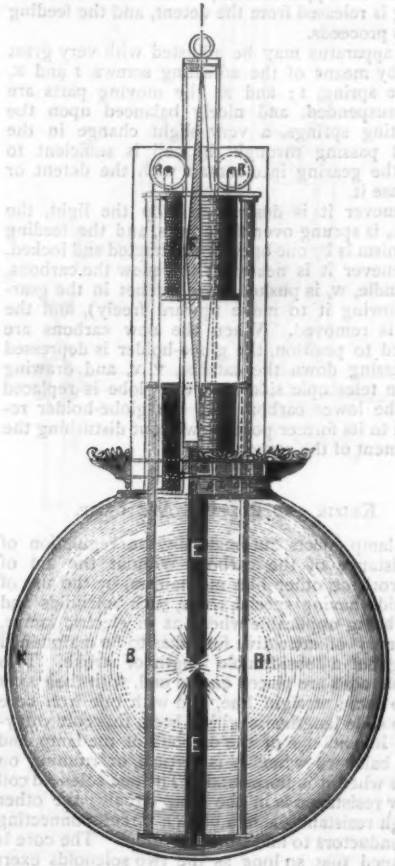


FIG. 10.

going change of attraction, and they are, therefore, suitable for regulating the distance of the carbons in electric lamps. Figs. 9, 10, and 11, show various constructions of lamps in which they are so applied. In fig. 9 the double-coned core, F, is attached to the socket of the upper carbon, the whole being balanced by a weight, *q*, attached to a cord passing over a pulley, R, and free to move within the two solenoid coils, S and S^1. The coil, S, of large wire presenting small resistance is in the circuit of the carbons, and S^1, in a shunt circuit, consists of fine wire in many convolutions, so as to get with a weak current magnetic force equivalent to that of S with a strong current, and to present considerable resistance. When the carbons are too near, the attractive power of S being increased while that of S^1 is diminished, the core, F, is attracted upwards,

FIG.5.

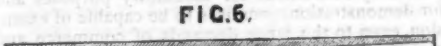


FIG.6.

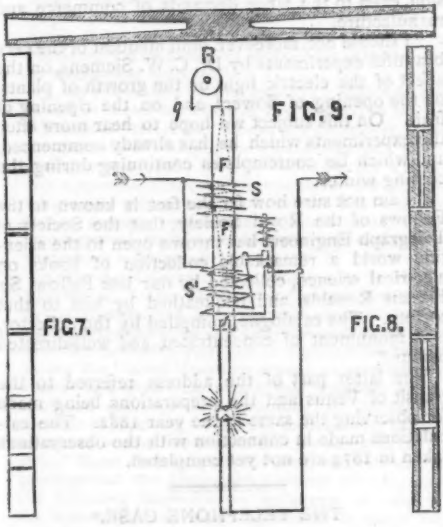


FIG.7. FIG.8. FIG.9.

separating the carbons. When, on the other hand, the carbons are too far apart, S loses force and S^1 gains force, so that the core, F, is attracted downwards, causing the carbons to approach. In fig. 10, showing a pendant lamp partly in elevation and partly in section, the core, F, and upper carbon, E, with its socket are balanced by the lower carbon, E^1, and the rods, B, B^1, which carry it, the pulleys, R, R^1, over which the balancing cords pass, serving as guides to the socket tube of the upper carbon. In this lamp the connections and action of the two solenoid coils, S, S^1, are as described with reference to fig. 9. A standard lamp, arranged to maintain a constant focal position of the arc produced by a continuous current, is arranged as shown at fig. 11, the racks, *z*, z^1, of two carbon sockets being connected by insulated gear, G, D, proportioning their movements to their respective rates of consumption. The shunt coil, S, may consist of two or more layers of thick insulated copper wire furnishing the convolutions required, with several layers of thin copper and German silver wire to provide the required resistance. An electro-magnet, M, acting on an armature contact lever, H, serves to short-circuit the coil, S, in case of interruption of the lamp circuit.

This lamp has recently been tried at the rooms of Messrs. Wells & Co., Shoreditch, we believe with considerable success.

THE ROYAL SOCIETY.

ADDRESS OF THE PRESIDENT.

THE anniversary meeting of the Royal Society was held on November 30th, when the President, Mr. W. Spottiswoode, D.C.L., LL.D., delivered the inaugural address.

In the first portion Mr. Spottiswoode alluded to the losses which the Society had sustained through the deaths of Professor Miller, Dr. Sharpey, Mr. Lassell, Professor Ansted, Lord Belper, Mr. E. W. Cooke, Sir Benjamin Collins Brodie, and others.

In the year 1880 123 papers had been received by the Society and published. The Society receives annually from Government the sum of £1,000 for promoting scientific investigation; none of this amount is applied to the personal remuneration of the applicant. The Society has also practically at its disposal a further sum of £4,000 in connection with the Government Science and Art Department.

The law relating to vaccination, the Royal Commission on accidents in coal mines, the voyage of the *Challenger*, and the work of the Meteorological Office, were alluded to.

Amongst the duties of the President is assistance in the organisation of the City and Guilds of London Institute. The work done in the latter was fully alluded to.

The progress made in spectrum analysis was next referred to.

With reference to the progress in electrical science, Mr. Spottiswoode spoke as follows:—

"The striking advances made in electricity during the last few years, and marked by, amongst other things, the inventions of the telephone and the microphone, have been followed by a step not less daring in its conception, nor less successful in its execution; I allude, of course, to the photophone, of the result of the researches of Mr. Graham Bell and Mr. Sumner-Tainter. The principle of this instrument is already known. A powerful beam of light is first thrown upon a flexible mirror, the curvature of which is modified through vibrations set up in it by the human voice. The reflected beam is then received by some selenium suitably disposed, and forming part of an electric circuit. The intensity of the light so received, and with it the resistance in the circuit due to the selenium, varies with the varying curvature of the flexible mirror. A large parabolic mirror is used at the distant station to concentrate the light on the selenium 'cell;' and a telephone in the circuit reproduces the variations in the form of sound.

"Mr. Bell has, however, also shown that rays from the sun, or an electric lamp, when rendered intermittent by any convenient means, will set up in a plate of almost any substance vibrations correspond-

ing to the intermittence. The substances as yet tried are: metals of various kinds, wood, india-rubber, ebonite, &c., and among them zinc appears to be one of the best suited for the purpose. This result, which is independent of any electric action, is, perhaps, due to heat rather than to light.

"In these, as in many other issues of scientific research, we can hardly fail to be impressed by the almost inexhaustible resources which lie ready to hand, if we only knew how to use them, for the interpretation of nature, or for the practical purposes of mankind.

"During the past year Professor Hughes employed his induction balance for the detection of very minute impurities in small masses of gold. Mr. Preece also has shown how slight increments of temperature in fine wires transmitting telephonic currents of electricity will suffice to reproduce sonorous vibrations, and even articulate speech at a distant station by their influence on thin platinum wires, only six inches in length.

"Mr. Stroh has shown that, at the point of contact of two metals carrying strong electric currents, adhesion takes place, varying with the nature of the surfaces in contact; and that many of the effects at points of contact, previously attributed to induction, may be due to the peculiar action now for the first time brought under notice.

"It is worthy of record, that two Atlantic cables have been successfully laid during the present year; but that success in the operation has become so much a matter of course that its occurrence has attracted little public attention. Two cables, each of more than 500 miles in length, have been laid across the Mediterranean; and the Cape Colony has been placed in telegraphic communication with this country by a cable of not less than 4,400 miles.

"Constant attention is paid in the General Post Office to the introduction of improved methods for the furtherance of the telegraphic communication throughout the country.

"Steady progress has been made in bringing the electric light into practical use. The illumination of the Albert Dock of the London and St. Katherine's Dock Company, the Liverpool Street Station of the Great Eastern Railway, the St. Enoch's Station of the Glasgow and South-Western Railway, and last, but not least, that of the reading-room of the British Museum, have become accomplished facts; while the City authorities have decided to extend the use of this light over various thoroughfares under their control. The subdivision of the light for domestic purposes is a problem which appears to have found a solution in the incandescent carbon lamp of Professor Swan. Beside this, Mr. J. H. Gordon has devised, for the same purpose, a very ingenious application of rapid sparks from alternating machines, such as that of De Méritens, to produce incandescence in refractory metals. Lamps constructed on this principle completely fulfil the conditions of subdivision, but some difficulties of detail still retard their adoption for general use. There is, however, every reason to hope that the experience already gained, and the intelligence at present brought to bear upon it, will before long supply us with more than one form of domestic light.

"The Conference on Lightning Conductors, composed of delegates from the Royal Institute of British Architects, the Society of Telegraph Engineers, the Physical Society, and the Meteorological Council, is steadily pursuing its labours. A large mass of facts has been accumulated; several leading questions have been decided; and it is hoped that, in the course of the coming year, the Report of the Conference will be issued.

"One of the most interesting, and at the same time useful, applications of the dynamo-machines, is that of transmitting mechanical power to spots, or under circumstances, where the ordinary appliances cannot be conveniently used. Their principle will doubtless by degrees extend itself over a wide range of industry, especially in localities where water-power is abundant. Perhaps one of the most remarkable instances of the application of the principle is that by Dr. Werner Siemens of the propulsion of railway carriages in Berlin.

"Our Fellow, Dr. C. W. Siemens in London, and M. De Méritens in Paris, have demonstrated the use of the high temperature of the electric arc in fusing refractory metals. The method of operation, while peculiarly convenient for laboratory purposes and for demonstration, promises to be capable of extension, even to the large demands of commerce and manufacture.

"I should not, moreover, omit mention of the very beautiful experiments by Dr. C. W. Siemens, on the effect of the electric light on the growth of plants, on the opening of flowers, and on the ripening of fruit. On this subject we hope to hear more after the experiments which he has already commenced, and which he contemplates continuing during the coming winter.

"I am not sure how far the fact is known to the Fellows of the Royal Society, that the Society of Telegraph Engineers has thrown open to the scientific world a remarkable collection of books on electrical science, collected by our late Fellow, Sir Francis Ronalds, and bequeathed by him to that society. The catalogue, compiled by the collector, is a monument of concentrated and well-directed labour."

The latter part of the address referred to the transit of Venus and the preparations being made for observing the same in the year 1882. The calculations made in connection with the observations taken in 1874 are not yet completed.

THE TELEPHONE CASE.*

In the High Court of Justice. Exchequer Division.

Before MR. BARON POLLOCK *and* MR. JUSTICE STEPHEN.

THE ATTORNEY-GENERAL *v.* THE EDISON TELEPHONE COMPANY, LIMITED.

THIS was a proceeding, technically said to be "by way of information," instituted by the Post Office for the purpose of determining whether the defendant company had infringed the monopoly of the Postmaster-General, given to him under the Telegraph Acts. There is another case pending against the Bell Telephone Company, which stands over until the determination of the present one, both cases having been instituted before the amalgamation of the two companies.

The printed pleadings comprise an "information,

* Specially reported for this JOURNAL by A. B. KEMPE, Esq., Barrister-at-Law.

in which the Attorney-General informs the Court of the matters complained of, and requests that certain prayers may be answered; an "answer" of the defendants, denying some of the allegations of the information and adding others; "admissions" by the defendants as to their mode of carrying on business; and a "replication" of the informant joining issue with the defendants. The material paragraphs of these pleadings were as follows:—

THE INFORMATION.

1. By the 31 and 32 Vic., cap. 110 (1868), the Postmaster-General is empowered to take over and work certain telegraph "undertakings." By sec. 3 of that Act "The term 'undertaking' shall mean the whole or any part of the electric and other telegraph wires, posts, pipes, tubes, and other works, instruments, materials . . . . and all other property whatsoever of any company, corporation, or persons engaged in the United Kingdom in transmitting messages for money or other consideration by means of electric or other telegraphs." And "The term 'any company' shall mean any company, corporation, or persons now engaged in the United Kingdom in transmitting or authorised to transmit messages for money or other consideration by means of electric or other telegraphs or mechanical agencies."

2. By the 26 and 27 Vic., cap. 112 (1863), which is referred to in the Act of 1868, it is enacted in sec. 3 that "The term 'telegraph' means a wire or wires used for the purpose of telegraphic communication, with any casing, coating, tube or pipe inclosing the same, and any apparatus connected therewith for the purpose of telegraphic communication." And "The term 'post' means a post, pole, standard, stay, strut, or other above-ground contrivance for carrying, suspending, or supporting a telegraph."

3. By the Telegraph Act, 1869 (32 & 33 Vic., cap. 73), sec. 4, "The Postmaster-General by himself or by his deputies and his and their respective servants and agents shall from and after the passing of this Act have the exclusive privilege of transmitting telegrams within the United Kingdom except as hereinafter provided, and shall also within that kingdom have the exclusive privilege of performing all the incidental services of receiving, collecting, or delivering telegrams except as hereinafter provided." By sec. 5 of the same Act, "There shall be excepted from the said exclusive privileges of the Postmaster-General all telegrams of the following descriptions: telegrams in respect of the transmission of which no charge is made, transmitted by a telegraph maintained or used solely for the private use and relating to the business or private affairs of the owner thereof: telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which or of the collection, receipt, and transmission or delivery of which no money or valuable consideration shall be or promised to be made or given." There are other exceptions, the only material one of which is, "telegrams transmitted with the written licence of the Postmaster-General."

4. The Telegraph Act of 1878 extended the operation of the former Acts to underground cables and pneumatic apparatus.

5. The Postmaster-General acquired the monopoly at a cost of over £10,000,000, and the yearly revenue is £1,250,000, of which nearly £200,000 is clear profit, and it is essential to protect the public revenue that the monopoly should be enforced.

6. Sets out the material parts of the Memorandum of Association of the Company.

7. Refers to the two patents of Edison worked by the Company. These are (1) a patent, No. 2909, dated 30th July, 1877, for "Improvements in instruments for controlling by sound the transmission of electrical currents and the reproduction of corresponding sounds at a distance." (2) A patent, No. 2396, dated 15th June, 1878, for "Improvements in telephones and apparatus employed in electric circuits."

8. Points out that it appears from the two specifications that the inventions include wires for the purposes of telegraphic communication, and apparatus for transmitting messages and other communication by means of electric signals.

9. Quotes from the earlier specification passages describing the inventions as "The acoustic or speaking telegraph," "a telegraph operated by sound," "an instrument for transmitting sounds by electricity," "an instrument for receiving sound telegraphically."

10, 11. Are immaterial.

12. In this paragraph the Attorney-General informs the Court that the wires and apparatus employed by the defendants constitute a telegraph, and gives an elaborate description of the instruments employed.

13 and 14 set out printed notices of the Company, stating the advantages of their system, and the terms on which they deal with customers.

15 and 16 set out a lengthy article from the *Times* of Monday, Sept. 8th, 1879, describing the mode in which the Company carries on business by the well-known Exchange system.

17. States that the Company, as a matter of fact, do carry on their business in the mode described by the *Times* article, and asserts that in so doing they have "transmitted or aided in and permitted the transmission of messages."

18. Sets out the Company's advertisement, which has appeared in several newspapers, and says that they act as therein stated.

19. Asserts that the wires of the system are not private wires, so as to bring the case within the exceptions of sec. 5 of the Act of 1869, but are at any rate as to part common to many subscribers.

20. Sums up, by re-asserting that the apparatus employed are telegraphs, that the messages are telegrams sent by the defendants for hire, and that the revenue will be seriously injured if they are allowed to carry on their business unchecked.

21, 22, 23, 24, 25, 26. Contain a correspondence between the defendants and the Post Office on the subject, in which the latter states that it "will not sanction the transmission of messages to greater distances than half-a-mile from the centres, not allow two or more centres to be connected;" and the former state that they "are advised by eminent counsel that the exclusive privilege of transmitting telegrams does not extend to the use of telephones in the manner proposed by the Company, and therefore do not propose to apply for a licence from the Postmaster-General."

27, 28. Give an account of a visit of inspection to the Company's Central Exchange by Mr. Graves, the Engineer-in-Chief, and Mr. Preece, the Electrician to the Post Office.

29. States that the Attorney-General waives all penalties.

The Information, in conclusion, prays:—

(1) That it may be declared that the wires and apparatus of the defendant Company are telegraphs within the meaning of the Telegraph Acts, and that messages or other communications transmitted by means of any such wires are telegrams within the meaning of such Acts.

(2) That it may be declared that the transmission by or with the aid or permission of the defendant Com-

pany, by means of any such wires and apparatus, of messages or other communications under or by virtue of contracts entered into upon the terms mentioned in the notices published and circulated by the Company, or upon any terms under which any money or other consideration is or shall be paid or given or promised to be paid or given to the Company, or of any other messages or other communications in respect of which, or of the collection, receipt, transmission, or delivery of which any money or other consideration has been or shall be paid or given or promised to be paid or given to the defendant Company, is an infringement of the exclusive privilege conferred on the Postmaster-General by the Telegraph Act, 1869.

(3) That the Company, their servants, and agents may be restrained from infringing that privilege.

(4) That an account may be taken of all moneys received by the Company in respect of the messages passing along their wires, with a view to the same being paid into the Exchequer.

(5) That such further or other relief may be given as the case may require.

THE ANSWER.

1, 2. Are immaterial.

3. States that "the Edison telephone, which is alone supplied by the Company, is an instrument for reproducing the words of audible and articulate speech by means of or with the aid of electricity. It enables two persons, without any previous acquaintance with the instrument, and without any code of signals, to converse directly with each other without the intervention of a skilled operator or any other person to transmit or interpret the communication. The Company was not formed for the purpose of transmitting messages, and they do not transmit messages, and they do not intend to transmit messages. Their only object is to lease telephones to corporations, companies, and persons, and to fix the private wires necessary to complete the electric connection and to maintain such telephones and wires in proper working order. The Company do not collect, receive, transmit or deliver any telegrams or other messages between any persons whatever, and they never let a telephone except under a contract in writing by which it is expressly stipulated that the telephone and apparatus, or the telephone, apparatus, and wire (as the case may be), are solely for the private use of the lessee, and are to be used exclusively for conversation by him, his clerks, servants, and others authorised by him, on matters relating to his business or private affairs, and are not directly or indirectly to be used in any way or manner for the transmission of messages for the public, and that the lessee shall not allow the same to be used for money or other valuable consideration by any person or persons whatsoever."

4. States that the operations of the Company are conducted in four different ways:—

(*a*) It leases telephones.

(*b*) It leases a pair of telephones and a private wire.

(*c*) It leases the telephones and sells the wire after fixing it.

(*d*) It works the well-known "exchange system."

5. Says that though no doubt the Company's wires might be used "for the purpose of telegraphic communication," and its apparatus "for transmitting messages and other communications by means of electric signals," still as a matter of fact they are never so used.

6. What is done is: "Two telephones by means of which articulate speech is reproduced are always connected by means of a wire extending from the speaker to the listener, and such wires are similar to the wires commonly used for the purpose of transmitting messages by the electric telegraph. But it is not the fact that any messages are transmitted by the apparatus so supplied by the Company."

7. The Company's apparatus reproduces at the receiving station sonorous vibrations of air corresponding to those produced at the transmitting station by the direct action of the human voice. "There is no preconcerted code of signals, and there is no third person interposed . . . . to interpret any such signal or to collect any message; and except in so far as actual speech between any two persons can be called a message (which the Company submit it cannot) any communications which pass are not telegraphic communications, nor are the instruments telegraphs, either within the meaning of the acts of Parliament or in ordinary language." In telegraphs, it is alleged, "the electricity or other efficient cause is usually put into action by the mechanical agency of the hand of the person transmitting the message."

8. Describes very fully the apparatus employed by the Company, including the "switch-board," by which the various subscribers are put into communication with each other, and the call-bell, as to the ringing of which "the Company submit to the judgment of the Court whether this is or is not an electric signal."

9, 10. Contain admissions by the Company as to the truth of paragraphs 12, 13, and 15 of the Information.

11, 12. State that the only places of business of the Company are the central exchanges, the terminal stations being the private places of business of the customers of the Company.

13. Is a general assertion that the Company have not violated the monopoly of the Postmaster-General, inasmuch as they have received no money for the transmission of messages or the communication, collection, or delivery of such.

14. Admits the correspondence referred to in the Information.

15. Admits the visit of Messrs. Graves and Preece to the central exchange.

16. Minutely describes the proceedings of the switch-boy at the central exchange, admitting that he has to be communicated with by the transmitter in order that the latter may be put into direct communication with the receiver.

17. Relates to certain agreements of the Company.

18. Asserts that no messages are transmitted by the Company, nor, as far as they are aware, by their customers, and that the only apparatus employed by the Company is telephonic.

19. States that the telephone was not invented until long after 1869, and at that date "no human being had the slightest idea that it would be possible so to extend the power of speech as to enable persons at a distance to converse with one another. There is no real similarity between the telephone and the various instruments used for telegraphic communication at the date of the passing of the Telegraph Act, 1869. The Company submit that there is no ground for so enlarging the monopoly conferred upon the Postmaster-General as to include the results of an instrument differing not merely in degree but in kind from the only instruments known or conceived of in 1869, and that the telephone is not a telegraph, and that direct conversation between any two persons by means of a telephone which reproduces audible and articulate speech is not the transmission of a telegram within the meaning of the Telegraph Acts."

20. The Company submits that even if a telephone is a telegraph, the operations of the Company fall within the exceptions of sec. 5 of the Act of 1869.

The admissions made by the defendants were as to

the existence of trunk wires used in common by different subscribers.

The case came on for hearing on Monday, 29th November, and lasted until the middle of the following Friday. The Attorney-General (Sir H. James, Q.C.), the Solicitor-General (Sir F. Herschell, Q.C.), Mr. E. E. Kay, Q.C., Mr. C. T. Simpson, Mr. W. W. Karslake, and Mr. J. F. Moulton, F.R.S., appeared for the Crown; Mr. Benjamin, Q.C., Mr. Webster, Q.C., and Mr. Cozens-Hardey (instructed by Messrs. Waterhouse and Winterbotham), appeared for the defendants. A great variety of apparatus was in court.

The ATTORNEY-GENERAL in opening the case for the Crown, stated that the present proceedings had been commenced on the 27th of November, 1879, in order to vindicate those rights of the Crown which had been placed in the custody of the Postmaster-General by the Telegraph Acts. The Crown did not ask for any penalties in this case, but wished that a monopoly which was exercised for the public benefit should be enforced. He referred briefly to the 7th and 8th Vic., cap. 85, sec. 13, 14, which compelled railway companies to permit telegraph lines to be laid alongside their rails, and to allow all persons "without favour or preference" to use such lines; and to the 24th and 25th Vic., cap. 97, sec. 37, which protected telegraph lines from injury. Prior to the Post Office Telegraph Acts, the telegraph companies were subject to the Act of 1863 (26th and 27th Vic., cap. 112). In 1868, by the 31st and 32nd Vic., cap. 110, the Postmaster-General was empowered to purchase the existing inland telegraph undertakings, and in 1869, by the 32nd and 33rd Vic., cap. 73, the exclusive monopoly in the transmission of messages was given to him. By the preamble of the latter Act it is stated that "in order to protect the public revenue, it is expedient that similar powers to those conferred upon the Postmaster-General with respect to the exclusive privilege of conveying letters should be enacted with reference to the transmission of public telegraphic messages within the United Kingdom." The whole purport of the legislation was the benefit of the public by *inter alia* reducing the expense of telegrams. The matter now in dispute was whether the apparatus employed by the defendants were telegraphs, and whether they transmitted or aided in the transmission of telegrams. This would require an investigation into what were "telegraphs" and "telegrams." It was remarkable that the definition in the Act of 1863 did not in any way refer to electricity, though it clearly, by its reference to posts and wires, included it. It was also remarkable that the later definition omitted all reference to wires, and makes "electric signals" the defining words. This was probably due to the fact that at that time there was talk of effecting direct communication through water. He then cited the exceptions from the monopoly given by sec. 5 (*see* Information), and argued that the defendants could not be brought within them, as they transmitted messages for gain. If he understood the defences that would be set up, they were (1) That the wires, posts, and apparatus of the Company are not "telegraphs" within the meaning of the Act; (2) that they come within the exceptions of sec. 5; (3) that the messages of the Company are also within the exceptions; (4) that the Company does not in fact send messages. The case he should put forward on the part of the Crown was this. Upwards of ten millions of public money had been spent in acquiring a privilege. What was the privilege which was obtained at so heavy a price? It could be and was nothing less than the exclusive right of conveying all messages by wire or other means for hire. If it could be shown that the defendants had transmitted messages by means of electric agency, they would be clearly within the terms of the Act, and the Crown would be entitled to recover. The defendants would say that the telephone could not be a telegraph within the meaning of the Act, as it was wholly unknown at the time when the Act passed. Such a contention could not be supported. If it could be the invention of railways would have overthrown a letter-carrying monopoly, instituted at the time when stage-coaches conveyed the mails, or the invention of the pneumatic despatch, the monopoly enjoyed in later times. The result of such an argument would be that each new telegraphic instrument, as it was invented, would deprive the Post Office of its monopoly. The legal authorities were clear upon the point. It had been held that words originally intended to apply to roads could apply to railroads. There was no desire on the part of the Crown to check invention; he most emphatically disclaimed that. Inventors and companies would always be dealt with in a liberal spirit if they consented to become licensees of the Crown; but the public interests must be protected, and those who infringed a monopoly created for a public benefit must be proceeded against. Turning to the meaning of the word telegraph, he said that there was an idea in the minds of some persons that a telephone could not be a telegraph, because the word *graph* implied writing; that, of course, was absurd. One had only to consider the earliest form of telegraph, the semaphore, to be disabused of such a notion. Telegraphs were of various kinds; there was the heliograph, and the nautical and military flag systems were telegraphic. In the affidavit of Mr. R. Sabine, a reference was given to the invention of telegraphs by Amontons in 1663. Sir W. Thomson, in the "Encyclopædia Britannica" of 1860, defines "telegraphic communication simply as the interchange of ideas between two intelligent beings by means of inanimate matter occupying space between them," though no doubt, in his affidavit on the part of the defendants, he now disclaims his definition, and says it is too wide.

Sir J. STEPHEN.—All this is no doubt very interesting, but is it to the point? I have carefully read through the affidavits, and it must be remarked that they are made by scientific men who are accustomed to make matters interesting to the public, and do not advance the question here, which is solely what is the meaning to be assigned to the words "telegraph" and "telegram" *as used in these Acts of Parliament*; of that we are the judges, not they.

The ATTORNEY-GENERAL said it would be necessary to consider what telegraphs were in use at the time of the passing of the Act of 1869; what progress was made up to the date of invention of the telephone; and what had been done subsequently. The defendants said the telephone was not an electric telegraph, but he should demonstrate that the three essential factors of a telegraph, viz., current, conductor, and means of varying the strength of current, were also the essential factors of telephonic apparatus, which, with all its great beauty, was only a very refined means of doing that which had been done somewhat coarsely before, viz., varying the strength of an electric current, and demonstrating the existence of the variation. Such an improvement could not deprive the Crown of a monopoly.

Sir J. STEPHEN.—It is clear that the Crown and the defendants both employ your three factors. The question will be whether the way they are employed is not totally different in the two cases.

Sir HENRY JAMES then proceeded to consider the various constituents of an electric telegraph. Pointing out that in all electric telegraphs there must be a curren

which might be generated by various means, he showed that in order that the current might be available for telegraphic purposes there must be some means of varying its strength; this might be done either by causing it to be intermittent or by gradual and continuous variation. The operator appealed to the senses of the receiver by these variations, and thus telegraphed to him. The senses appealed to might be any one of the five. Originally in the needle telegraph the sense of sight was appealed to. If the Crown had then been in possession of the monopoly, would it have lost it when Bright's telegraph, which worked with two bells, and, moreover, by magnetic currents without a battery, was brought out? The telegraph most in use by the Post Office was Morse's. That worked by variations of current strength, which were demonstrated by long and short ticks of the receiving instrument.

Mr. BENJAMIN.—It does not work by variation, but by interruption. It is a very different thing.

The ATTORNEY-GENERAL.—The question is one purely of degree. If the defendants were going to rely on the difference between interruption and variation they would fail, as Sir W. Thomson in 1858 in his syphon recorder, and Mr. Varley in 1862, both employed variable currents, as their patents would show; the latter expressly says, in his patent No. 3543, that he works "by the increment and decrement of electric currents."

Mr. BENJAMIN.—I confined my remark to the Morse instrument, which you were demonstrating.

The ATTORNEY-GENERAL.—The Morse instrument communicates ideas by what is termed a conventional code. To those who operate the code is no more conventional than language is to most people. Language is merely not conventional because it is known to a number of people. If it be said that with a telephone you can tell who is speaking, it may be replied that a Morse operator can tell who is communicating with him. It is said that the telephone differs entirely from the instruments that preceded it. To demonstrate that this was not so, the Attorney-General first showed that by rapidly breaking contact at the transmitting end, a continuous note, varying in pitch, could be produced at the receiving end. A combination of such notes, by means of Stroh's vowel sounder, was shown to produce vowels, and Stroh's siren was made to say "papa." This led up to Edison's phonograph, the action of which was stated to be similar to that of the telephone, as to which it was then said it was impossible that the Court could say that it was so different from anything that preceded it that the monopoly of the Postmaster extended up to the time of its invention, and then ceased. The great diversity of instruments employed in telegraphy was illustrated by reference to Wheatstone's automatic transmitter, Hughes' printing telegraph, the writing telegraphs of Bonelli, Arlincourt, and Cowper, as to the last of which it was stated that it worked by variation and not by interruption, Mr. Justice Stephen remarking that it was the first real telegraph that had been shown or mentioned to them. Turning to the telephone, the Attorney-General said, that as pointed out in the Information, Mr. Edison himself called it a telegraph. As to the statement in the "Answer," that before 1869 no human being knew of or dreamed of the telephone, that was not true. In the "Exposé des Applications d'Electricité," par le Viscomte du Moncel, Paris, 1857, the following views of M. Charles Bourseul are quoted:—"I ask myself, for example, if speech itself could be transmitted by electricity, in a word, if one could not speak at Vienna and make oneself heard at Paris. The thing is practicable, and thus . . . . I imagine that one speaks near to a mobile plate sufficiently flexible not to lose any of the vibrations produced by the voice, that such plate establishes and breaks successively communication with a pile. You can have at a distance another plate, which will execute at the same time the same vibrations. It is true that the intensity of the sounds produced will be variable at the point of departure where the plate vibrates by the voice and constant at the point of arrival, where it will vibrate by electricity. But it is shown that this cannot alter the sounds . . . . Any one who is not deaf and dumb could make use of this mode of transmission, such would not require any sort of apparatus. Any electric pile, two vibrating plates, and a metal wire would suffice." Again, the well-known invention of Reis, upon which the telephone is based, was invented in 1860.

The COURT.—It is really immaterial when the telephone was invented. The question is, Is it a telegraph within the Act?

The ATTORNEY-GENERAL then proceeded to deal with the mode of carrying on the business of the Company, pointing out that it was impossible in the face of the trunk lines, which unquestionably belonged to the Company, and of the switch-boy, who undoubtedly aided in the transmission of messages, to say that the Company did not come within the Act. In conclusion, he remarked that if the operations of the Company were extended the danger to the revenue would be a very serious one.

The evidence in the case was then gone into. This, according to practice, was in the form of printed affidavits, the witnesses being in court to be cross-examined if desired. Much of the evidence went to establish the statements in the pleadings, and much of it consisted of the opinions of scientific men of eminence as to what, in their opinion, constituted a telegraph. This, as will have been seen, was considered by the Court to be irrelevant. We shall give short extracts from the affidavits on such points as seem of interest.

Mr. E. GRAVES, the engineer-in-chief of the Post Office Telegraphs, says: "It is my undoubted opinion that every apparatus for communicating intelligence from one place to another at a distance from it, by means of the passage of currents of electricity along a wire or wires between such places, is an electric telegraph, as I have for the last twenty-seven years understood the expression." He gives the following list of the various instruments in use by the Post Office on March 31st, 1879:—

Printers.—Morse	... ...	1324
Automatic	... ...	151
Hughes	... ...	6
Acoustic.—Morse	... ...	1572
Quadruplex	... ...	10
Bell's	... ...	260
Visual.—Needle	... ...	3541
A B C	... ...	4916
Miscellaneous	... ...	242
Telephones	... ...	22

He quotes from the "Encyclopædia Britannica" of 1860, the following words of Sir W. Thomson as to a "telegraph": "The term has been from the beginning, and is constantly still applied to apparatus for communicating intelligence to a distance in unwritten signs, interpretable by an intelligent being from their effects perceived through his senses of sight or of sound, and has, in fact, only recently had application to those wonderful combinations of inanimate matter which literally write at a distance the intelligence committed to them. We may, therefore, define telegraphic communication simply as the interchange of ideas between two intelligent beings by means of inanimate matter occupying space between them."

Mr. W. H. PREECE gives a very full description of the instruments employed in telegraphy. He also quotes a definition of a "telegraph" from Nichol's "Cyclopædia of the Physical Sciences" of 1857: "A telegraph is an instrument used for the purpose of conveying intelligence to a greater distance than the sound of the voice can reach without a messenger."

Mr. ROBERT SABINE gives a number of definitions of telegraphs from a variety of books of all dates.

Mr. VARLEY relates how he purchased a pair of Reis's instruments in 1862, and made various experiments with them. When a tune was sung into the transmitter the effect at the receiving instrument "was much as if the tune was sung by a gruff voice." He considers that the tunes were "telegraphed from one instrument to the other."

Mr. LADD gives an account of how he came across Reis's instrument at an instrument maker's in Friedrichsdorf, and sets out a letter he received from Reis on the subject, dated July 13th, 1863, in which it is said that "Any sound will be reproduced if strong enough to set the membrane in motion."

Sir CHARLES BRIGHT say that in telephony "no sounds whatever pass from the sending station to the receiving station. Nothing passes between the two stations except impulses, or currents of electricity;" and that it is his "deliberate opinion that the wires and apparatus of the defendant Company are telegraphs."

Mr. LATIMER-CLARK is of opinion "that the wires and apparatus of the defendants are to all intents and purposes telegraphs." He considers "the facts that the mechanical agency of the voice of the sender of the message is used to set electrical force in action, and that the sounds produced at the receiving station resemble the words uttered at the sending station are not material to the question of whether the apparatus is a telegraph. Between the sending and receiving stations there is or are a wire or wires in electrical connection; and when a message is transmitted by means of that wire or those wires, nothing passes from one station to the other but currents or waves of electricity, which are used to communicate intelligence from the sending station to the receiving station."

Mr. D. E. HUGHES says that telephones "are, in truth, only new kinds of transmitting and receiving instruments."

Mr. BARLOW states that "the word 'language,' although originally applied to some action of the tongue, is often used as including any means of conveying thought or intelligible meaning by sight or sound. All telegraph instruments now employed in this country for the transmission of intelligence by electrical agency between distant places, convey language or intelligible meaning received either by sight or by marks or by sound. In all the means employed in electric telegraphy one common principle is involved. They all convey their language or intelligence by a species of articulation made by alternate actions and cessations of actions of more or less duration. And I say that in all the instruments employed in transmitting intelligence by electricity, whether the action or effect is conveyed to the receiver by sight or by sound or by marks, it is the articulation thus given to the language which renders it intelligible." He further states that his well-known invention, the "Logograph," proves "that the articulations of the human voice, although it is accompanied by varying vowel sounds, is, like that of the telegraph instruments, made by certain relations in the duration and cessation of action."

Dr. WARREN DE LA RUE is of opinion that "an electric telegraph may be defined as an apparatus so constructed that by means of a series of electric currents or impulses transmitted at intervals through or along a wire or wires, from one station to another station at a distance, a series of corresponding impulses is produced at the distant station."

On the part of the defendants, the Right Hon. E. P. BOUVERIE, the Chairman of the Company, and Mr. ARNOLD HENRY WHITE, the Secretary, testify to the truth of that part of the "Answer" which relates to the mode in which the Company carry on business.

Sir W. THOMSON states that at the time he wrote the paragraph referred to in the affidavit of Mr. Graves, he "had not the slightest idea that an electric telegraph wire could be used for the transmission of speech;" and he considers that the telephone cannot be correctly described as a telegraph within the Acts of 1863, 1868, and 1869, "which I have read." He further says, "I cannot conceive it to be possible that so entirely novel an application of electrical science as these instruments involve can be considered to have been included in the monopoly which Parliament gave to the Post Office Department. When the Telegraph Acts were passed the telephone had not been invented, and no one concerned in that legislation had the slightest idea, nor had any one living the slightest idea, that it would be possible so to extend the power of speech as to enable persons at a distance to converse with one another. Previously to the invention of the Bell and Edison telephones, the only mode of communicating between two persons at a distance was by personal messages or by writing, or by the use of some previously arranged code of signals, or by voice tubes. The musical toy invented by Reis about the year 1860 was not in any sense a speaking telephone, nor could it transmit articulate speech."

Professor G. G. STOKES states that the telephones of Bell and Edison "are entirely novel inventions, and are based upon new applications of electrical science of the greatest interest and importance. There is no real similarity between the speaking telephone and the various instruments used for telegraphic communication, except that both require the agency of electricity, and therefore a battery, or magnet, and a wire to conduct the current is essential to both. Neither the transmitter nor the receiver of the telephone in any way resembles in their mode of operation the corresponding parts of a telegraphic instrument; and if a single word is to be used to include both a telephone and a telegraph, it must, in my opinion, be wide enough to cover every instrument which may ever be invented which employs electricity transmitted by a wire as a means for conveying information. I draw the broadest possible distinction in my own mind between mere improvements in the mode of sending and receiving a preconcerted code of signals, and a discovery of so totally novel and unexpected a character and so different in its results as that of the telephone."

Professor TYNDALL says: "I have never on any previous occasion expressed an opinion in any legal proceedings on questions affecting the application of science to the uses of life, and I have always steadfastly declined to do so when requested; but, having explained the principles and illustrated the action of the telephones of Mr. Graham Bell and Mr. T. A. Edison in the lecture theatre of the Royal Institution, I am desirous that my silence should not be misinterpreted, and I have, therefore, on this occasion consented to express the opinions hereinafter contained. Comparing, in the first place, the ordinary telegraph with the scientific results achieved before that telegraph became a patented invention, and comparing, in the second

place, the telephones of Bell and Edison with the existing telegraph, the advance as regards novelty and originality is, in my opinion, vastly greater in the second case than in the first. The one was a difference of degree, the other is a difference of kind. Prior to the labours of Bell and of Edison it had never, to my knowledge, entered into the thoughts of scientific men to transmit by means of electricity the tremors of the human voice, so as to reproduce audible and articulate speech at a distance. The proof that this was not only possible but practical appeared to those most familiar with experimental physics to be an application of electrical and acoustical science not only new but marvellous. I have, therefore, no hesitation in expressing the opinion that to confound the telephone with the telegraph would be to place in the same category utterly dissimilar things."

Dr. GLADSTONE considers that a telegraph is a "mode of communicating intelligence to a distance greater than the human voice will naturally reach, by means of a code of arbitrary signals previously agreed upon." He also considers that a telephone is not a telegraph, but "involves an entirely novel application of electrical science," and is "distinct in principle from all previous applications of electricity to the transmission of intelligence."

Professor CAREY FOSTER considers that the "words 'telegraph' and 'telegraphic communication,' which I find used in the Telegraph Acts, must mean such forms of instrument and such methods of communication as were known and used at the date of the Acts, with such further inventions as may fairly be considered as modifications or improvements of these." He asserts that no essentially new principle is involved in Reis's invention, but that the telephone "depends upon two distinct discoveries, one relating to the communication of vibrations between solid bodies and the air, the other to the employment of the vibrations excited in solid bodies by sound waves to cause periodic variations in the strength of electric currents. I am satisfied that before the invention of the speaking telephone no one knew, and few physicists would have believed, that the same solid body was capable of taking up from the air all the countless and minute varieties of vibratory motion which are concerned in the production of articulate speech. Again, no one knew that, even if it were possible, to cause the strength of an electric current to vary periodically at one part of a long conducting circuit in a manner corresponding with the vibrations of articulate speech, these minute variations would still be sufficiently perceptible at a distant point, and retain in a sufficient degree their individual character to make it possible to produce by means of them at that point audible vibrations exactly corresponding to those by which they had themselves been produced at the first point."

Dr. FLEMING says: "In Reis's instrument there was no intermediate stage between current on and current off, no graduation of current, and, therefore, no possibility of transmitting a current whose strength varied with the variation of air-pressure. This instrument had no claim to be called a telephone in the sense of a speech transmitter, inasmuch as it never did and never could transmit the infinitely more complicated waveforms of speech." He continues: "In my opinion the Edison telephone may be properly described as an apparatus by which one person causes the air at a distant station to vibrate in an exactly similar manner to that in which it vibrates close to his mouth, and this is what happens in ordinary speech." "In a telegraph, as ordinarily understood, the idea of a signal is an integral part of the notion; and, apart from a recognised code and a pair of trained observers at either end, the electric telegraph is of no practical use to the public." He also remarks: "When I, standing in one closed room, shout to another person in an adjoining room, the waves of sound from my voice beat against the wall, transmit their motion to the particles of the wall, and these, again, hand on the motion to the air in the other room. In this case the molecules of the wall constitute an apparatus by which motion of the air in one place is repeated in another. The Edison telephone does just the same thing."

Baron JULIUS DE REUTER says that, if in 1869, he had believed the telephone "to be within the limits of practical science, and had desired to describe it," he should "certainly not have used the word 'telegraph.'"

Mr. SYMINGTON of Glasgow describes the A B C exchange as worked by him in that city, and states that although the Post Office threatened him with proceedings in 1875, they never followed the matter up.

Affidavits on the part of the Crown were read in reply to these.

Sir CHARLES BRIGHT, in reply to Sir W. Thomson, says that in 1868 he was a member of Parliament for Greenwich, and had at that time read the Viscomte du Moncel's book, and had considered the possibility of carrying out the idea of M. Charles Bourseul.

The ASTRONOMER ROYAL and Professor ADAMS say that no identity between aerial vibrations and electric currents can be reasonably said to exist, as we know nothing of the laws governing the operations of electric impulses. They say also that no conclusion can be drawn from any supposed identity of the mathematical expressions for such vibrations and currents. The meaning of any particular expression in mathematics depends on the meanings assigned to the symbols, which may be various and utterly dissimilar.

Dr. C. W. SIEMENS considers that telephones are telegraphs.

Mr. S. M. YEATES of Dublin describes experiments made by him with Reis's instruments. He greatly improved on it, and in 1865 succeeded in transmitting the sound of the voice so that the voice of the person sending the sound could be recognised.

Mr. SPOTTISWOODE, the President of the Royal Society, without expressing any opinion as to the proper construction to be put upon the word "telegraph," as used in the Telegraph Acts, is personally of opinion that the telephonic apparatus is merely a new form of transmitting and receiving telegraphic apparatus.

Affidavits were then read on the part of the defendants.

Lord RAYLEIGH, the Professor of Experimental Physics in the University of Cambridge, asserts that telegraphy involves a code of signals; that the telephone is not a telegraph, but is "an instrument for artificially extending, by the use of electricity, the limits through which the human voice is audible." "The only essential difference between a speaking telephone and a speaking tube is, that in the former vibrations are transmitted in the electrical, in the latter in the aerial form."

Dr. HOPKINSON considers that "It is essential to the idea of a telegraph, or to the idea of signalling, that signs, other than the articulate speech which we or others learn in infancy, should be the mode of communication. The electrical vibrations in a conducting wire, which occur when words are spoken into or heard from a telephone, do not imply electric or any other sort of telegraphy. Whatever may be the ultimate nature of these electrical vibrations, they certainly have the characteristic that they correspond in every

particular with, and are in form similar to, the vibrations of ordinary matter when transmitting the same sounds. Indeed, the mathematical expression of the electric current at any point of the telephone wire is the same as the mathematical expression of the movement of the air at any point outside the telephone. Without straining the use of the words, we may say that the currents in the telephone wire transmit sound in the same sense that the movements in the air around us transmit sound. In the case of writing telegraphs and printing telegraphs the case is very different; the electrical states of the wire have no similarity to or other than a wholly conventional and artificial correspondence with the written or printed character."

At the conclusion of the reading of the evidence it was agreed between the learned counsel on both sides that there should be no cross-examination of the witnesses, who were thereupon released from further attendance.

(To be continued.)

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXIII.

THE WHEATSTONE AUTOMATIC SYSTEM.

THIS important instrument is now very largely used in the United Kingdom for the transmission of ordinary and press message work over the main trunk wires, and also at race meetings where a large amount of work is required to be done in a short time; indeed, without the help of the Wheatstone instrument it would be impossible to transmit, without heavy delays, the large amount of work which has daily to be carried on. At the present time over 170 automatic instruments are in daily use, working up to a speed, in some cases, of 200 words a minute. At present this rate of working is found sufficient for all purposes, but there is but little doubt that a much higher speed can be obtained if necessary; indeed, a speed of 250 words has actually been obtained between London and Glasgow with the existing form of apparatus.

The Wheatstone apparatus consists of three parts, viz.: the *puncher*, the *transmitter*, and the *receiver*. The former is employed for preparing a slip of paper for transmission through the transmitter, and it is worked either by direct blows or by pneumatic action controlled by finger keys.

To understand thoroughly the action of the apparatus it will be convenient to consider first its general principle.

Fig 86. represents a facsimile of the punched paper strip for the transmitter, and the corresponding slip with the recorded signals as it passes out of the receiver.

On the punched paper strip there are three rows of holes; the holes in the centre row are equidistant, and are for the purpose of enabling the paper slip to be drawn forward at a uniform rate through the transmitter. For this purpose the latter is provided with a small star wheel turned by the clockwork, the teeth of this wheel gear into the perforations in the slip, and draw the latter forward by a rack and pinion movement.

The upper and lower sets of perforations, which are rather larger than the middle row, are for the purpose of controlling the currents sent out by the transmitter.

Figs. 87, 88, 89, represent the controlling mechanism in the transmitter.

C, Z, are two bell-crank levers, pivotted at the angles and connected to the zinc and copper poles respectively of the battery. The spiral springs, s_3, s_4, made of stiff brass wire, tend normally to pull the two longer ends of the levers together; the inside part of these ends are faced with platinum and between them are two platinum pins, p_3, p_4, fixed to the disc, D.

Referring to fig. 88, it will be seen that if the two platinum faced ends of the levers could both rest at the same time against one or other of the pins, p_3, p_4, that the battery would be short-circuited; this is prevented by means of a small screw, *a*, which is screwed through the end of the lever, C, and whose end touches against a small piece of ebonite, *e*, fixed in the end of the lower lever, Z. The screw, *a*, is so adjusted that the distance between the two platinum faces is rather greater than the diameter of either of the pins, p_3, p_4, thus the circuit of the battery cannot be closed through either of the pins.

The disc, D, is divided into two halves insulated from each other, so that the pin, p_3, is insulated from the pin, p_4. The disc is axled behind at its centre so that it can rotate through a small angle to the left or right as required. A steel tail piece projects from the top and bottom of the disc, and against the top one a jockey wheel, E, set at the end of a spring, presses; the object of this wheel is to keep the disc firmly in either of the two extreme positions it may assume—that is to say, with the top tail piece against either the left or right-hand stops between which it plays.

It will be noticed that when the disc is in the position shown in fig. 87 that the copper pole of the battery is connected to the pin, p_4, and the zinc pole to the pin, p_3. When the disc is rotated until the top tail piece comes over against the left-hand stop pin, as shown in fig. 89, then the zinc pole is connected to pin, p_4, and the copper pole to pin, p_3; thus the right and left-hand movement of D reverses the battery relative to the pins, p_3 and p_4, that is, relative to the two insulated halves of D. The "Up" line being connected to the right-hand half of the disc, the rocking of the latter connects the zinc and copper poles alternately to it.

Y is an ebonite beam which is caused to rock at its centre by means of the train of clockwork which drives the star wheel before referred to. This beam is provided with two platinum studs or pins, p_1, p_2, the left-hand one of which is connected permanently to the "Down" line. These two pins normally press against two bell-crank levers, A, B; the horizontal arms of these levers are pulled upwards by means of the springs, s_2, s_4.

The levers being hinged directly on to the frame of the apparatus are in electrical contact with one another.

To the crank, A, a rod, H, is hinged, whose end passes through a hole in the tail piece, P. A small collet, K^1, is screwed on to H, which, when H is moved to the right by the action of the crank, A, presses against the tail piece, P, and rotates the

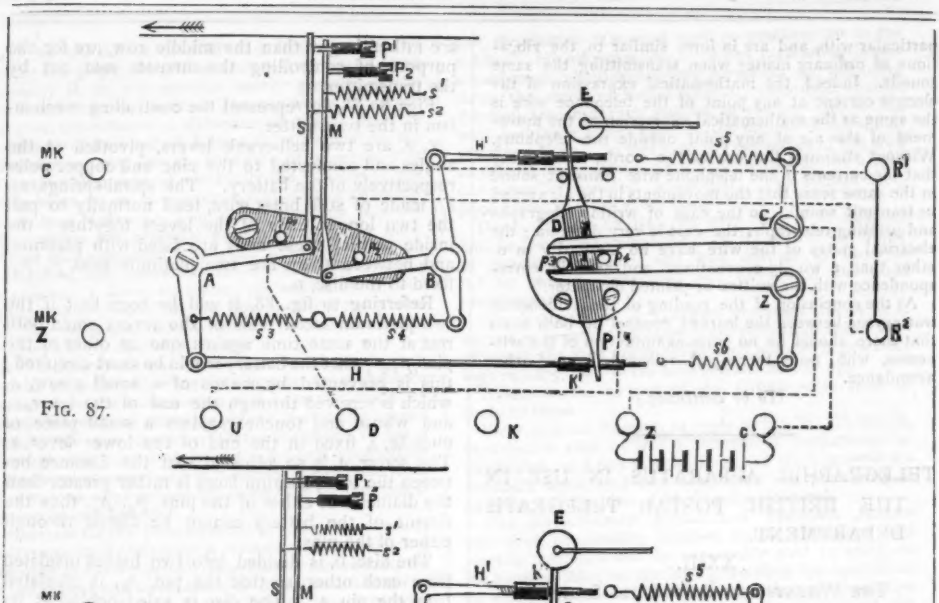


FIG. 87.

FIG. 88.

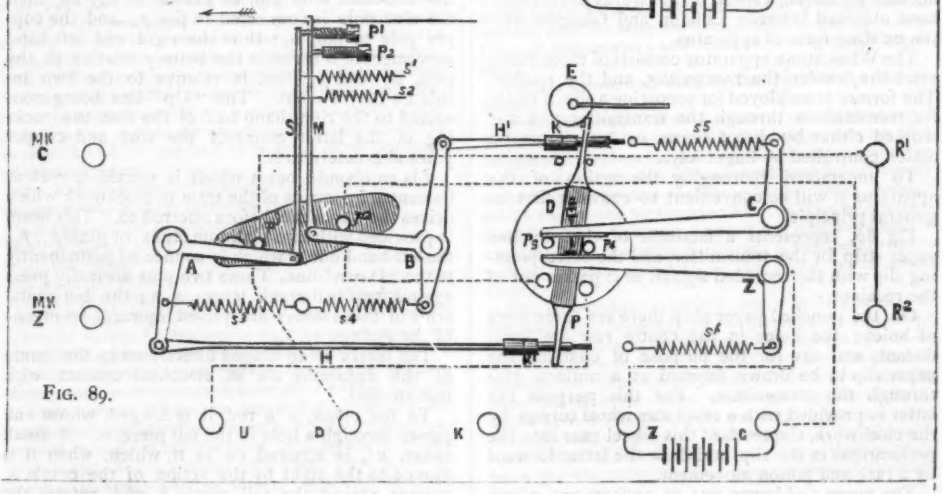


FIG. 89.

disc, D, over to position shown in fig. 87. Similarly, the collet, K, on the rod, H^1, can press against the top tail piece, and throw the disc, D, over to the position indicated in fig. 89.

The collets, K, K^1, can be adjusted by being screwed forward or backward; their correct position is such that when the parts are in the position indicated by fig. 88, K nearly touches the upper tail piece and K^1 nearly touches P.

Besides the connections already referred to, it will be noticed that the right-hand pin, p_3, on the beam, Y, is connected to the left-hand half of the disc, D.* The two pins on the beam, Y, are also connected to two terminals, R_1, R_2, which, as a rule, are short-circuited by a brass strap.

Supposing now the beam, Y, is caused to rock by the clockwork connected to it being allowed to run, then the pins, p_1, p_2, on the beam will alternately depress the crank levers, A and B, and the motions of the two latter, through the medium of the rods, H, H^1, will cause the disc, D, to rock in unison. As has previously been explained, the latter motion will cause the copper and zinc poles of the battery to be alternately connected to the "Up" line. Now, the pin, p_3, on the disc, D, being in connection with the right-hand pin, p_2, on the rocking beam, and also, through the terminals, R_1, R_2, with the left-hand pin, p_1, and the "Down" line, it will be evident that when p_2 touches the end of lever Z, and p_4 touches the end of lever C, as in fig. 87, that a copper current will flow to the "Up" line, and a zinc current to the "Down" line; also, when the position of the disc, D, is that shown in fig. 89, then a zinc current will flow to "Up" line and a copper current to "Down" line. Thus, by the continual rocking of the beam, Y, positive and negative currents will be alternately sent out to the "Up" and "Down" lines.

At the ends of the crank levers, A, B, are pivotted two steel rods, S, M. Now, supposing the whole mechanism to be in the position indicated in fig. 87, then a copper current will be flowing out to the "Up" line and a zinc current to "Down" line. Next, suppose that the beam, Y, commences to rock over to the position shown in fig. 89. Now, if the whole of the moving parts were free to move, then, as has been explained, the disc, D, would be rotated until the top tail piece comes over against its right-hand stop pin; but if the end of the rod, S, came against an obstruction, then the spring, s_2, would be unable to pull the crank lever, A, so as to keep it against the left-hand pin, p_1, of the beam, Y. Although, therefore, the latter would have come to the position shown in fig. 89, yet, since the crank lever, A, did not follow it, the disc, D, would still be left in the position shown in fig. 87, that is to say, a copper current would continue to flow to the "Up" line, and a zinc current to the "Down" line. Similarly, if the disc, D, had been rotated over to the left, as in fig. 87, so that the direction of the current was the reverse of that previously indicated, and the rod, M, had been prevented from rising, then, on the beam, Y, rocking back to the position shown in fig. 89, the spring, s_1, on the crank piece, B, would be unable to pull the latter so as to move the disc, D, over again to the right, and consequently the current would remain unreversed.

Suppose, now, the paper slip represented by fig. 86 be passed from right to left over the ends of the rods, S, M, then the se rods, being set at a distance apart equal to the distance between the rows of holes on either side of the centre row of perforations on the paper slip, will in succession pass

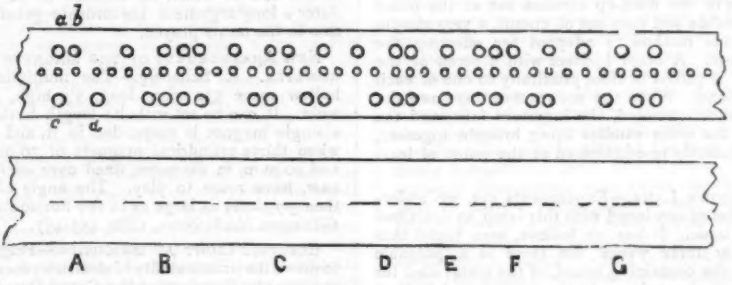


FIG. 86.

through these holes, and thereby allow the disc, D, to be thrown over in one direction or the other, according as the rod, S, or the rod, M, passes through a hole.

Assuming the mechanism to be in the position indicated by fig. 88, let us imagine the slip represented by fig. 86 to be in such a position that the end of the rod, M, is under the hole, *a*. When the mechanism is set in motion, the rod, M, will pass through this hole, *a*, unobstructed, and consequently the disc, D, will rotate over to the position shown in fig. 89, and a current in one direction will pass out to the line. As the mechanism continues to move, the paper slip moves forward by means of the star wheel before referred to, and when it has gone sufficiently forward the rod, S, enters the lower hole, *c*, on the slip, and the disc, D, becomes rotated over to the left, and thus the current becomes reversed. As the slip moves forward again, the rod, M, enters the second top hole, *b*, of the slip, and again the current becomes reversed; when, however, the rod, S, again rises, the second lower hole, *d*, on the slip being behind the top hole, *b*, last referred to, does not come forward in time to allow S to pass through it, consequently the disc, D, cannot be rotated, and the current remains unre-

* This connection has been accidentally omitted in fig. 87.

versed. Again, when the rod, M, in turn rises, it has no perforation to pass through, and so the disc, D, still remains unaffected; when, however, the rod, S, rises for the third time, it has now the hole, *d*, to pass through, and consequently the disc, D, can be rotated and the current reversed In one case, then, we have a current, followed almost immediately by a reversal, and in the second case, a current followed after an interval by a reversal. These currents being received on a polarised relay, as in the ordinary double current system, it is obvious that a dot and dash would be produced.

Notes.

THE JAMIN LIGHT.—Probably before the end of this week the first important exhibition of the Jamin light in London will have taken place. As we have previously stated, Messrs. Samuel Brothers are to have their new building illuminated by that system. The lamp is almost precisely similar to that described in our issue of July 1st of this year. There are, however, two slight alterations in its use: one is that the weight of the movable carbons is nearly counterpoised, and secondly, that instead of the spring arrangement for pushing one of the used-up carbons out of the plane of the horseshoe and then out of circuit, a very simple and ingenious method is adopted for effecting the latter purpose. A brass L-piece with a screw of the same metal is placed in close proximity to one of each pair of carbons. When the arc reaches this screw the current is short-circuited, the armature falls, and the carbons of the other candles being brought together, the arc is instantly re-established at the point of least resistance.

MR. GORDON'S LAMP.—Experiments are, we understand, still being continued with this lamp, as described in our last issue. It has, we believe, been found that after two or three weeks' use there is a palpable deposit, on the containing vessel, of the metal used for the small ball electrodes. As the costly metal iridium had been found the most advantageous generally, for these electrodes, it became necessary that the deposit should, to render the lamp sufficiently economical for ordinary use, be recoverable. Trying this in a somewhat primitive or rough fashion, the inventor has succeeded in achieving success to the extent of about three-fourths of the whole loss by combustion. We have been asked by some of our readers if with this lamp there is not a noise, but we hear that when the metal balls are once properly adjusted—that is, as close as possible without contact—there is no noise whatever to be noticed. Unlike the ordinary incandescence lamps, which cool rapidly, and therefore show every variation of the current, this lamp gives a most steady light, notwithstanding slightly unequal speed of the machine or engine. This is doubtless to be accounted for by the fact that the loss of heat in the inner balls is made up by a rush of heat from the outer balls, and also from the slower cooling properties of iridium over those of carbon.

THE HARMONIC TELEGRAPH.—On a Boston line it has been found possible to send simultaneously by one wire, and analyse at the other end, four distinct tones, thereby transmitting four separate messages in one direction at one time. This offers a signal advantage over the quadruplex system, which transmits two separate messages simultaneously each way, but cannot send four messages one way. In cases of extraordinary pressure of business the full capacity of the harmonic system may be utilised in either direction. It is hoped that the harmonic system will ultimately make possible the simultaneous sending of four or five messages both ways on a single wire; in other words, four tone messages and one ordinary Morse message in each direction, or ten in all. In this way all the tones of the octave will be made use of, and that is the probable limit of the system, unless it be found possible to operate with fractional tones.—*Scientific American.*

THE first number of a periodical, devoted to the subject of instruments, will be issued January 1, 1881. It will be published in Berlin under the name of the "Zeitschrift für Instrumentenkunde," and will be prepared by a board of twenty-one editors, including the most noted instrument makers of Europe and representatives of different branches of science in which instruments of precision are employed. Such a periodical is greatly needed, and the names of the editors are a guarantee of its success.—"O. S." in *Science.*

WERDERMANN *v.* SOCIÉTÉ GENÉRALE D'ELECTRICITÉ.—This was a motion, on Friday, the 10th, before Vice-Chancellor Bacon, on behalf of the plaintiff, for the usual preliminary order for accounts and for an injunction to restrain the defendants from selling or disposing of the patent well known as the Jablochkoff system of electric lighting, in which the plaintiff had a joint interest, and of which he claimed to be the inventor. After a long argument his lordship granted an injunction in the terms prayed.

NEW ARRANGEMENT OF THE MAGNETS OF A GALVANOMETER. K. Schering.—The multiplier contains a hollow space 532 m.m. long, 5·5 high, and 72 m.m. wide. It can be set with its length horizontally when a single magnet is suspended in it, and set vertically when thirty cylindrical magnets of 50 m.m. in length and 10 m.m. in diameter, fixed over each other to an axis, have room to play. The angle of deviation is then 3·7 times as large as in the horizontal position.—*Göttingen Nachrichten*, 1880, 455-457.

ELECTRIC LIGHT AT BRIGHTON.—Brighton is about to prove the practicability of electricity for street lighting purposes by illuminating the Grand Parade therewith.

THE ANGLO-AMERICAN ELECTRIC LIGHT CORPORATION (LIMITED.)—The prospectus of the Anglo-American Electric Light Corporation (Limited), of 74, Hatton-garden, and Victoria Works, Lambeth, has just been issued. It is formed for the purpose of taking over the business and extending the operations of the Anglo-American Electric Light Company (Limited.) The capital is to be £800,000 in 80,000 shares of £10 each, only half the number of shares will be included in the first issue. £1 is to be paid on application, and £3 on allotment. It is stated that the profits of the Corporation will arise from (1) the manufacture and sale of dymano-machines and lamps, and the sale of carbons; (2) the sale of continental, colonial, and other patent-rights; (3) the letting-out of lights worked from central positions; (4) contracts with corporations and other public bodies, and with private firms and individuals. For further particulars, see advertisement, page ix.

A METHOD OF PRODUCING THE ANOMALOUS MAGNETISM OF STEEL BY MEANS OF THE CURRENT OF A BATTERY. Bartoli and Alessandro.—The anomalous magnetisation of steel, first recognised in 1863 by Waltenhofen, and repeatedly observed by Righi, has been confirmed by the authors, who used a Daniells' and six Bunsen elements. With twenty elements the magnetisation was merely normal. If on opening the magnetising current the spark was avoided, no anomalous magnetisation was obtained with from one to twenty Bunsen elements.—*N. Cim.*, viii., p. 16.

THE French Government, on the 10th inst., laid on the table of the Chamber a demand for a grant of three hundred thousand francs in favour of the International Electricity Exhibition and Congress. The Government points to the patriotic sentiments with which the subscribers of the guarantee fund are animated, and begs the Chamber to participate in a work which must prove most valuable to the advancement of a science which has lately made such rapid strides, and which promises to render such great additional services to the whole civilised world. One hundred and fifty thousand francs are applied for in favour of the exhibition itself, but the Government, wishing to keep the direction of the Congress in its own hands, asks for another one hundred and fifty thousand francs to cover all expenses.

THE Great Eastern Railway Company have decided to fit one at least of their Continental steamers with the electric light.

A CONTRIBUTION TO THE ANALYSIS OF ELECTRIC DISCHARGES. W. Holtz.—The electrodes (tin-foil points) between which the sparks of an induction apparatus were striking were made to revolve up to 100 times per second on an ebonite disc of 12 c.m. diameter. When the distance traversed by the sparks is very small the extension of their image is greatest. It is reduced by decreasing the number of the exciting elements and the number of the iron wires in the inductive coil, or by increasing the resistance of the air. The image consists of a great number of parts separated by intervals, and has a short, bright anterior end, followed by a dark violet train, differing in length. On connecting the poles of the induction apparatus with Leyden jars, the larger the jars the more the total extent of the image of the spark and of its parts is shortened; the violet trains disappear, and the heads become brighter. This shows that the intermittent luminous phenomenon does not depend on an intermittent excitement of electricity within the coil, but merely on an intermittent discharge of its end-surfaces: for with the increase of the polar surfaces, and with prolongation of the distance traversed by the sparks, the quantity of electricity of the several discharges is increased at the cost of their number. Exactly similar phenomena are observed on discharging Leyden jars with the intercalation of moist cards when the ends of the cards are connected each with a smaller Leyden jar just before the track of the sparks. The length of the entire image increases with the size of the surface of the battery.—*Göttingen Nachrichten*, ix., p. 345.

M. SOMZÉE, a Belgian engineer, proposes to utilise the safety lamp for revealing the presence of fire-damp in collieries. It is well known that the flame of the lamp elongates and acquires a higher calorific power when in air which contains light carburetted hydrogen, or marsh gas. A piece of metal is so placed as to be elongated by this flame; this produces electric contact, and causes a bell to ring. Several of these lamps should be placed in different parts of the mine, and the bells numbered.

ONE of the dials of the Westminster clock is to be illuminated by the electric light on the Brush system.

NEW ELECTRIC DUST-FIGURES AS A CONTRIBUTION TO THE EXPLANATION OF THE PHENOMENA IN GEISSLER TUBES, AND TO THE REFUTATION OF THE HYPOTHESIS OF CROOKES. Yvon Zoch.—Tubes of 10—30 c.m. in length and 1—3 c.m. in width were closed at each end with corks, through which were passed copper wires. Bronze-powder was introduced: other lighter powders which were tried adhered to the sides of the tube under the influence of the discharge in consequence of static charges. One wire was connected with the positive conductor of an electric machine, whilst the other permitted the supply of electricity to escape into the air. In certain cases the electricity was furnished by a charged Leyden jar, and the pressure of the air was that of the atmosphere. The bronze-powder displayed then very beautiful stratifications, which differed in their arrangement according to the original position of the powder. Around the positive pole there was formed a larger or smaller space free from the powder, which was chiefly collected at the negative pole. If the current had been allowed to pass for a time and the poles were then charged the strata disappeared and the chief part of the powder collected in the middle of the tube, probably owing to its static charges. The phenomenon agrees closely with Quet's stripes.

The author compares these distributions of the bronze-powder with the stratification of the gases, showing that both are influenced by the same circumstances, such as the quantity of electricity passing at each discharge, the width of the tube, the charge of its outer sides. As a repulsion of the particles situate near the electrodes could here be directly observed, the author considers that the stratification in Geissler's tubes depends on mechanical causes, as is assumed by De la Rive. He thinks, however, that not the rarefied but the condensed strata are luminous. He explains the stratification thus: as the electricity enters the tube, the sides and the gaseous molecules become saturated, and are repelled from the electrode and from the sides. The electrode moves the gas to the negative pole, and the sides of the tube impel it more feebly towards the axial line. From the reciprocal action of these forces result strata like the dust-figures seen in narrow streets after a high wind. As the bronze-powder is chiefly accumulated at the negative pole, the author concludes that the maximum density of the gas in Geissler's tubes is found at the negative pole. He seeks to explain the stratification in flames, the figures of Lichtenberg, &c., on the same principles. The author appends some remarks on Crookes' experiments, which he explains in accordance with his figures, and thus refutes the hypothesis of the fourth state of matter, but without submitting it to any thorough discussion.—*Beiblätter* (Wiedemann's), iv., No. 10.

CANADIAN TELEGRAPHY.—Mr. J. A. Gisborn, superintendent of the Canadian Government telegraph lines, has returned to Ottawa, after having successfully laid a submarine cable connecting Anticosti, Magdalene Islands, Bird Rocks, and Cape Breton. It is stated that the Canadian Government is about to build a line from Sydney Mines to Cape North, touching at Lloyd's Cove and Englishtown; and that St. Paul's Island will be connected by cable. On St. Paul's Island a semaphore will be placed at the north-east end, so that all vessels passing up or down the gulf will be reported.

ON the 11th inst., at the Physical Society, papers were read "On the rate of loss of light from phosphorescent surfaces," by Lieutenant Darwin, R.E., and "On the determination of chemical affinity in terms of electromotive force," by Dr. Alder Wright.

ADHESION OF METALS OCCASIONED BY ELECTRIC CURRENTS.—If two masses of metal, *e. g.*, two wires, or, better, two blades, the one fixed and the other attached to a lever, are brought together at an angle of

90°, and if a current is then passed through them they adhere together, according to the observations of A. Stroh. If the circuit is repeatedly closed there is heard a slight report at the point of adhesion, even if far remote from the closing point. The adhesion is strongest in the case of hard steel (=225 grm.) weaker in soft steel (100 grm.); then follow iron, platinum, lead, gold, zinc, silver, copper, decreasing as the conductive power increases. Microscopic examination shows that the edges are fused together at the point of contact, a strong heat being at first produced by the current. As the metals melt and larger surfaces are brought into contact the heat decreases. The report is due to the sudden expansion of the point of contact. Steel edges are rendered harder at the point of contact so that they scratch the file.—*Naturfascher*, xiii., No. 49.

A PROPORTIONAL part of the expense of lighting the Southwark and Blackfriars bridges by the electric light will be paid out of the Bridge House funds.

MR. EDISON is making arrangements for trying his incandescent lamps over 7½ miles of streets in Menlo Park and neighbourhood.

MESSRS. J. AND H. BERGE, of New York, have just completed a very large and finely-constructed double-plate Holtz electrical machine for E. N. Dickerson, Esq. This is probably the largest Holtz machine ever made, the revolving plates being forty-five inches in diameter, and other parts in proportion. By means of a continuous charging apparatus attached to the machine, the inductors may be readily charged without recourse to the catskin and rubber-plate. The machine, together with the charging apparatus, is mounted on a massive mahogany table, which is sufficiently large to support any apparatus used in experiments. By an ingenious arrangement of mechanism the crank which rotates the large plates is made to turn the charging apparatus. This machine is capable of yielding a 26-inch spark, accompanied by a report that is really startling. By way of contrast, this firm exhibit a diminutive Holtz machine having a 5-inch revolving plate, and yielding a 1-inch spark.—*Scientific American.*

THE following are the arrangements for the Friday evening meetings of the Royal Institution of Great Britain before Easter, 1881: January 21, Warren De La Rue, D.C.L., F.R.S., Sec. R. I., The Phenomena of the Electric Discharge with 14,400 Chloride of Silver Cells; January 28, Dr. Andrew Wilson, F.R.S.E., The Origin of Colonial Organisms; February 4, Dr. Arthur Schuster, F.R.S., The Teachings of Modern Spectroscopy; February 11, Robert S. Ball, LL.D., F.R.S., The Distances of the Stars; February 18, Sir John Lubbock, Bart., M.P., D.C.L., F.R.S., M.R.I., Fruits and Seeds; February 25, Dr. J. S. Burdon-Sanderson, LL.D., F.R.S., Excitability in Plants and Animals; March 4, Sir William Thomson, LL.D., F.R.S., Elasticity viewed as possibly a Mode of Motion; March 11, uncertain; March 18, Wm. H. Stone, M.D., Musical Pitch and its Determination; March 25, Alexander Buchan, M.A., F.R.S.E., Sec. Met. Soc. Scot., The Weather and Health of London; April 1, uncertain; April 8, Prof. Tyndall, D.C.L., F.R.S., M.R.I.

THE Watch Committee of the city of Liverpool invite tenders for lighting by means of the electric light several of the principal streets of that town.

ON THE SPACE PROTECTED BY A LIGHTNING-CONDUCTOR.—In the *Philosophical Magazine* for December is a paper bearing this title, by Mr. W. H. Preece. The author, after fully discussing the subject, says: "*Hence a lightning-rod protects a conic space whose height is the length of the rod, whose base is a circle having its radius equal to the height of the rod, and whose side is the quadrant of a circle whose radius is equal to the height of the rod.* I have carefully examined every record of accident that I could examine, and I have not yet found one case where damage was inflicted inside this cone when the building was properly protected. There are many cases where the pinnacles of the same turret of a church have been struck where one has had a rod attached to it; but it is clear that the other pinnacles were outside the cone, and, therefore, for protection, each pinnacle should have had its own rod. It is evident also that every prominent point of a building should have its rod, and that the higher the rod the greater is the space protected."

THE annual report of the president of the Western Union Telegraph Company for the year ending June 30th, 1880, furnishes many figures of interest to others than the stockholders of the company. The latter, however, appear to have no reason to complain, the net profits of the company for the year footing up over 5,000,000 dols., the capital stock of the company being about 41,000,000 dols. The net profits for the fourteen years from 1866 to 1880 exceed 45,000,000 dols. The telegraph business of the year is represented by 29,215,509 messages, 12,782,894,53 dols. receipts, 6,948,956,74 dols. expenses, and 5,833,937.79 dols. profits. The company has in operation 85,645 miles of line, 233,534 miles of wire, and occupies 9,077 offices. The new offices established and equipped during the year number 543. The number of messages sent was over 4,000,000 more than the year before. The increase in mileage of wire was 22,000 miles; the increase in miles of pole lines was 2,658. The ratio of expenses was 54 3-10 per cent. of the receipts, against expenses of 56 2-10 per cent. the previous year, and of 63 9-10 per cent. the year preceding that, and the cost per message reduced to the average of 22 3-10 cents, against 23 1-10 cents the previous year, 25 cents the year preceding that, and 29 8-10 cents the year ending in 1877. —*Scientific American.*

TRIALS have been lately made on the Rhine, in order that navigation may be carried on at night by means of the electric light.

THE TELEPHONE AND FIRES.—The Leeds Water Works and Fire Brigade Committees are about to adopt telephonic communication between the town-hall police station and the turncock's residence at the water works.

THE Committee of the Bristol Sanitary Authority have authorised the sum of £500 to be expended in experiments in the way of lighting the town by the electric light.

GAS has been readopted in the St. Lazare Station of the French Great Western Company, the gas company having declared that they would abolish entirely the special price charged on the Great Western Company if they declared in favour of gas.

THE Charing Cross Station of the South Eastern Railway is, it is said, to be lit by the Brush system, and the Cannon Street Station by the British Electric Light Company.

Correspondence.

FAST SPEED ON CABLES.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—With regard to the article in the TELEGRAPHIC JOURNAL, No. 187 (Nov. 15, 1880), on fast speed working on cables, I am glad to state that the German Government more than two months ago placed on their cables a system of duplex telegraphy with unrivalled success. The system is the invention of Geheimer Ober-Postrath Ludewig, one of the superintendents of the Postal Telegraph Department here. The arrangement can be used with equal success for aërial, underground (submarine) lines everywhere and for all distances, *where translators can conveniently be inserted.* [The italics are our own.—ED. T. J.] The carrying power is more than doubled by the employment of this duplex system.

Geh. R. Ludewig has authorised me to carry on all transactions with foreign parties, and I shall be glad, therefore, to furnish any particulars required.

Yours truly,

EMIL RATHENAU.

Berlin W., 5, Eichhorn-Str.,
Nov. 28th, 1880.

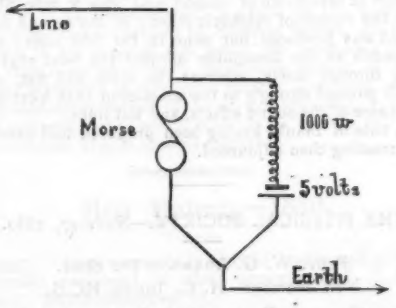
[Our correspondent has somewhat mistaken the drift of our article; the latter had reference to long ocean cables where translators *cannot* be inserted. Translators for increasing the speed of working on long lines have been extensively adopted in the British Postal Telegraph Department.—ED. TEL. JOUR.]

VYLE'S RELAY.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—To the description of Mr. Vyle's (or Mr. Brown's) adaptation of the Hughes' electro-magnet to relaying purposes, and to the subsequent information which has appeared in your columns, allow me to add that it is not only possible to magnetise the cores in the manner adopted by Mr. Bolton, but it is not necessary to use separate coils for that purpose.

An ordinary Morse instrument of about 120 ohms joined as below works well by double current on any ordinary line, with the usual working current of 8 or 10 milliwebers. A Morse or sounder wound to a higher resistance than that usually used would, with a permanent magnet, not only simplify and cheapen the apparatus, but would facilitate adjustment, relays being no longer necessary.



It would appear, indeed, that when the molecules of the core are twisted from their locked position of rest by a current, or by a permanent magnet, that they then accept motion with greater ease, and this seems to be the chief cause of the extreme sensitiveness of the Bell telephone and this instrument, while it is worthy of note that the armatures are induced through the attracting cores only.

Yours truly,

G. EDEN.

Govt. Telegraphs, Edinburgh.
December 7th, 1880.

CIRCULAR CARBON ELECTRODES.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I beg to forward you a copy of a letter I have sent to the editor of *La Lumière Electrique*. As it has reference indirectly to an article which appeared in your last issue, I shall feel obliged by your giving publicity thereto.

Yours truly,

CHARLES. F. HEINRICHS.

To the Editor of "La Lumière Electrique."

SIR,—I have noticed your remarks in the last issue of *La Lumière Electrique* on the subject of my ring-armature, and also your statement as to my "re-invention" of the Dubos regulator. As regards the latter, I beg to call your attention to the following facts, viz.:—That last summer when I had the pleasure of an interview with you, I proved to your satisfaction that the date of my British patent relating to my electric lamps with semi-circular carbon pencils is prior by quite two months to any of M. Dubos' patents relating to electric lamps with circular carbon pencils; that the "only similarity" of Dubos' regulator with mine is in the application of circular carbon pencils; that there has been no electric lamp with circular carbon pencils shown to the public prior to my patent and to my lamps. Thus the priority of the application of circular carbon pencils belongs to me.

It is therefore with surprise that I read your statement, but feel sure that your attention being called thereto, you will, in justice to me, make in your next issue due amends for what I trust is but the outcome of inadvertence.

Your obedient servant,

CHAS. F. HEINRICHS.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AN ordinary general meeting of this Society was held on Wednesday, December 8, Mr. LATIMER-CLARK, past President, in the chair. The minutes of the last meeting having been read and confirmed, the list of new and proposed members was read.

A paper was then read by Mr. W. H. PREECE, President, on "The Photophone and the Conversion of Radiant Energy into Sound." Mr. Preece commenced his discourse by apologising for the incompleteness of the experiments, as there had been but a limited time to prepare them; he also announced that Professor Bell had come over specially from Paris to be present at the lecture and to take part in it himself. Mr. Preece stated that he was honoured in having been able first to introduce to the notice of the Society the telephone, the phonograph, and the microphone. He then proceeded with the general subject of his paper. Sound is a physiological action producing a sensation on the ear; it cannot exist independent of

the brain, it being purely undulations in the molecules of matter. To produce the effect known as sound three things are necessary, viz., a "transmitter," a "medium," and a "receiver." Whenever air is set in vibration sound is produced. If two tuning-forks be set close together, and one be sounded, the vibrations set up in the air will cause the second fork to vibrate and render a sound audible. In the case of Wheatstone's telephonic concert the sounds from musical instruments were conveyed along wooden rods, and rendered audible to the senses by a sounding board placed on the ends of the rods, thus enabling the vibrations to be imparted to the air. With reference to the subject to which the title of his paper referred, radiant energy existed in every physical force, as, for instance, in light, where the luminous relations were radiated from the source. In the spectrum we have radiant energy existing in its component form. If an electric circuit containing a telephone be continually interrupted and made a sound due to a series of clicks is produced, and if these clicks follow one another rapidly a musical note is produced; to produce articulation, pitch, loudness, and quality are necessary. How can radiant energy vary the strength of a current so as to vary the current in a telephone and produce articulation? Mr. Willoughby Smith discovered that radiant energy in the form of light affected the electrical resistance of selenium. Lieut. Sale, Professor Adams, Dr. Siemens, Lord Ross, and others proved that the effect was due to light and not to heat. Dr. Siemens also showed that the resistance varied according to the intensity of the light, and proposed to construct a photometer on the principle, but the experiment failed owing to the variable nature of the selenium. The question whether the effect of light was to vary the resistance or to generate an electro-motive force had been tried by Professor Adams, and it was proved that a slight photo-electromotive force was produced, though there could be no question but that the resistance was also affected. Mr. Crookes tried an experiment with his radiometer by coating the vanes on one side with selenium and the other side with chromic oxide. It was found that a white light from a wax candle caused the selenium surfaces to retreat, whilst the yellow light from a sperm candle caused the chromic surfaces to retreat. Mr. Sabine in 1878 (*see* TEL. JOUR., Aug. 1, Aug. 15, Sep. 1, 1878) made some experiments with two plates of selenium immersed in a cell filled with water. He found that when one of the plates was exposed to the light a current was generated in one direction, whilst if the other plate was the one exposed the current became reversed. Professor Minchin had attacked the subject from a photographic point of view, viz., he studied the actinic effect on chemicals (*see* TEL. JOUR., Sep. 15, Oct. 1, Oct. 15, 1880). He tried two plates of tinfoil immersed in hard water, and found that a current was produced by exposing one plate to the action of light; the direction of the current, however, became reversed after a time. With reference to the cause of the action of light on selenium, Mr. Preece did not venture to express a theory. Professor Bell had expressed an opinion that light could be made to produce sound, and Mr. Willoughby Smith had actually succeeded in doing this to a slight extent. The great difficulty in making the experiment had been in producing a piece of selenium of a sufficiently low resistance. This had been done by Professor Bell in the peculiar form of cell he had devised. Mr. Shelford Bidwell had followed up Professor Bell, and had produced an equally effective cell (*see* TELEGRAPHIC JOURNAL, Dec. 1st). (Mr. Bidwell's experiments were repeated with an Edison receiver, and an audible sound was produced by a rapidly intermitted beam of electric light falling on the selenium cell.) Mr. Preece, in conclusion, quoted some poetic extracts, which appeared to have foreshadowed the possibility of hearing light.

Professor BELL, who was received with acclamation, then proceeded to describe the experiments which he, with the assistance of Mr. Summer-Tainter, had made. Up to the present time selenium was the only substance which had been proved to be actively sensitive to light as regards its electrical resistance. It seemed probable that other non-metallic substances, such as tellurium, sulphur, and phosphorus would be similarly affected. Indeed, sulphur, when heated to a certain point and cooled slowly, conducted; and the experiment might be tried with it, though it had not yet been done. From the fact that very rapid makes and breaks could be heard in an electro-magnet, Professor Bell was led to conclude that all matter might be affected. At first the experiments with light on matter failed, but when experimenting with the selenium photophone it was found that a sheet of thin ebonite interposed in the path of the beam of light did not extinguish the sound, and subsequently, on placing the sheet of ebonite on the ear, and allowing the beam of light to be intermitted upon it, a sound was heard. Other substances were tried with like effect. It then occured to Professor Bell that if the light acted on the *surface* of the substance that the greater sound would be produced on that side, the intermittent light was therefore allowed to fall inside, and on the sides of a tube to which an ear-piece was connected, and a good sound was heard. It was further found that if the beam of light were thrown directly into the ear a sound was produced by the intermittence of the beam. The experiments were chiefly made by inclosing the substances acted upon in a test-tube, to which a flexible pipe and ear-piece were connected (*see* TELEGRAPHIC JOURNAL, Nov. 1, 1880). The electric light was found to produce better effects than sunlight.

In the discussion which followed the discourses,

Professor ADAMS stated that he had found that selenium changed its resistance greatly by time, a specimen which gave originally a resistance of 7,600,000 ohms in 1876 fell as low as 745 ohms in 1877. He stated that the electromotive force set up in the selenium was but very small, and that the change that took place was chiefly in resistance.

Professor TYNDALL said that there could be no doubt but that other substances than selenium were affected by the action of light. He could corroborate the results of the experiments made by Professor Bell, as he had personally witnessed them. He thought, however, that the effects were possibly due to heat, and not to light. As a test experiment he had tried a test-tube filled with vapour of bisulphide of carbon, and also a tube filled with the vapour of sulphuric ether; in the second case sound was produced, but none in the first case; and inasmuch as the bisulphide allowed the heat rays to pass through freely, whereas the ether did not, the result pointed strongly to the conclusion that heat was the cause of the sound effects, and not light.

A vote of thanks having been proposed and passed, the meeting then adjourned.

THE PHYSICAL SOCIETY.—Nov. 27, 1880.

PROF. W. G. ADAMS in the chair.

New member—H. C. JONES, F.C.S.

PROF. GRAHAM BELL exhibited his photophone, and explained the apparatus employed by Mr. Sumner-Tainter and himself for transmitting sounds by a beam of light. The form in use consists of

a metal plate or mirror vibrated by the sound and reflecting a beam of light to a distance, where it is focussed on a selenium cell in circuit with a telephone and battery. The light undulates in sympathy with the vibrations of sound, and alters the resistance of the selenium in accordance with the vibrations, thereby reproducing the sound in the telephone. The electric light used was too unsteady to give articulate speech; but by means of a rotating disc, perforated round its rim with holes, the light could be occulted in such a manner as to give an audible note in the telephone. Different varieties of receivers were described, some of which have not yet been tried. One of these consisted in varying the rotation of the plane of polarisation of the polarised beam. A plan for transmitting the beam consists in making the vibrating plate vary the supply of gas to a jet or manometric flame. The farthest distance speech has been heard by photophone is 800 feet; but theoretically it should operate better the greater the distance between the mirror and selenium. On interposing a sheet of hard rubber in the ray the invisible rays passing through it conveyed the sounds in a lower degree, and sounds can be heard by replacing the selenium receiver by discs of different materials, such as hard rubber, metal, &c., and simply listening at them. All substances appear to possess the power of becoming sonorous under the influence of varying light. Hard rubber, antimony, zinc give the best effects; paper, glass, carbon, the worst. Even tobacco smoke in a glass test-tube held in the beam emitted a note, as also did crystals of sulphate of copper. When hard rubber was simply made into the form of an ear-tube and held in the beam the audible effect was also produced, and, in fact, when the beam was focussed in the ear itself, without any other appliance whatever, a distinct sound could be perceived.

Prof. ADAMS thanked Prof. Bell in the name of the Society, and called on Mr. SHELFORD BIDWELL, who exhibited a lecture photophone, in which the reflector for receiving the light was discarded and the beam focussed on the selenium by a lens. The two lenses used cost only twenty-five shillings, and the beam was sent fourteen feet. The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallising it by heat. For mica Prof. BELL recommended microscopic glass. The resistance of the cell was 14,000 ohms in the dark and 6,500 in the light. Speech was distinctly transmitted by this apparatus.

Mr. J. SPILLER thought that since selenium probably alloyed with brass and the baser metals, it would be better to use gold and silver for the cells; but Prof. BELL said that he preferred brass, since (perhaps for the reason that Mr. Spiller gave) it yielded the best results.

Dr. J. H. GLADSTONE read a paper on the specific refraction and dispersion of isomeric bodies, an extension of his paper of last June. He concluded that the dispersion of a body containing carbon of the higher refraction is very much greater than that of a body containing carbon of the normal refraction, 5; and that isomeric bodies which coincide in specific refraction coincide also in specific dispersion.

New Patents—1880.

4933. "Improvements in electric lamps and in the materials employed in their construction," J. W. SWAN. Dated November 27.

4940. "Improvements in signals or communications between passengers and companys' servants when travelling by railway, and in other modes of signalling." J. UPTON. Dated November 27.

4952. "Improvements in furnaces and in the metallurgy of copper and in the method of varying the electrical conductibility of copper." A. M. CLARK. (Communicated by J. Garnier.) Dated November 27.

4961. "Mechanical contrivances for electro-magnetic clocks and apparatus." J. MAYR. Dated November 29.

4981. "Improvements in and relating to telephonic apparatus." W. R. LAKE. (Communicated by C. A. Randall.) Dated November 30.

4988. "Electric lamps." K. W. HEDGES. Dated November 30.

5004. "Improvements in measuring and recording electric currents and in the apparatus employed therein." J. W. SWAN. Dated December 1.

5007. "Mariners' and azimuth compasses." J. READMAN. Dated December 1.

5008. "Electro-magnetic induction machines." H. WILDE. Dated December 1.

5014. "Improvements in and connected with electric lamps." J. W. SWAN. Dated December 2.

5022. "Improved means for indicating the heating of bearings in steam-engines and other machinery." H. W. WIMSHURST. Dated December 2.

5033. "Improvements in electric lamps." J. H. JOHNSON. (Communicated by A. de Méritens.) Dated December 3.

5051. "Timepieces worked by electricity." W. P. THOMPSON. (Communicated by A. Lemoine.) Dated December 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

1580. "Dynamo-electric machines." EDWIN POWLEY ALEXANDER. (A communication from abroad by Karl Zipernowsky, of Buda-Pest, in the Austrian Empire.) Dated April 17. 6d. Relates to a construction of dynamo-electric machines, whereby they are rendered capable of producing electrical currents of great ten-

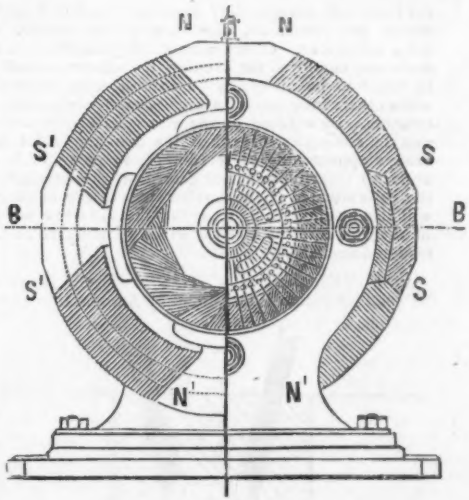


FIG. 1.

sion, suitable for maintaining a number of lights in one circuit, or for maintaining lights or producing mechanical power at considerable distances. Fig. 1 of the drawings represents a half-end elevation and half-transverse section of the said improved dynamo-electric machine; fig. 2 is a longitudinal vertical section of the same. The apparatus consists of a cylindrical armature, wound longitudinally with insulated wire, and carried in bearings in the framing, B B, and rotated

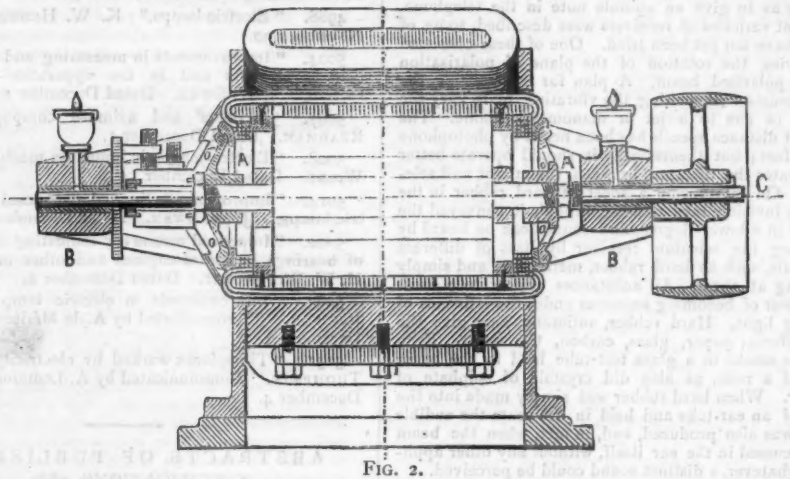
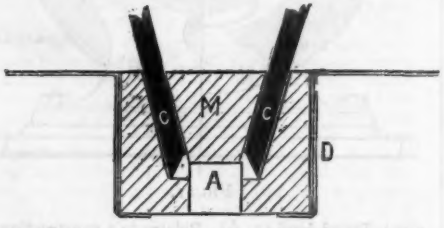


FIG. 2.

between the ring-shaped magnets, N N, S S, N^1N^1, S^1S^1. By means of the driving pulley, C, there are provided polar extensions projecting inwards, and so arranged that those of opposite polarity follow each other. By the rotation of the armature the currents produced in the same will change their direction 4 or 6 or 8 times during one revolution, according to the number of polar extensions. Of the currents so produced, one or more are employed for exciting the electro-magnets, in order to be utilised as dynamo-electric currents, while others form separate circuits as magneto-electric currents. By winding on the wire coils of the armature in rectangles, of which the two long sides are always approaching or receding from polar fields of opposite polarity, as before described, the portions of the coils situated at the smaller sides of the rectangle will also be effective by reason of the inductive action of the iron core, so that the whole of the wire coil is rendered available.

1704. "Electric lamps." HERBERT JOHN HADDAN. (A communication from abroad by Antoine Bureau, of



Belgium.) Dated April 26. 6d. Relates to a new type of electric lamps, and consists in guiding the voltaic arc in a block of refractory material, and in the method of rendering the light constant and of the desired tint. For this purpose the contiguous extremities of the carbons are embedded in the refractory material and the latter cut out, as shown by the figure, so as to form a vault directed towards the side which is to be illuminated. At the top of this vault are two orifices, which communicate with the points of the carbons, thereby forcing the arc to take the prescribed way.

The following are the final quotations of telegraphs for the 13th inst.:—Anglo-American Limited, 63½-64; Ditto, Preferred, 92½-93½; Ditto, Deferred, 34½-35; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9⅝-10⅛; Cuba, Limited, 8⅞-9¼; Cuba, Limited, 10 per cent. Preference, 16¼-16½; Direct Spanish, Limited, 2¾-3¼; Direct Spanish, 10 per cent. Preference, 12¼-12⅝; Direct United States Cable, Limited, 1877, 11½-12⅛; Scrip of Debentures, 102-104; Eastern, Limited, 9¾-10; Eastern 6 per cent. Preference, 12¾-13; Eastern, 6 per cent. Debentures, repayable October, 1883, 102-106; Eastern 5 per cent. Debentures, repayable August, 1887, 102-105; Eastern, 5 per cent., repayable Aug., 1899, 104-107; Eastern Extension, Australasian and China, Limited, 10-10¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 101-103; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 103-105; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 10-10⅛; Globe Telegraph and Trust, Limited, 6¾-7; Globe, 6 per cent. Preference, 12¼-12⅜; Great Northern, 11-11¼; Indo-European, Limited, 25-26; London Platino-Brazilian, Limited, 5¾-6¼; Mediterranean Extension, Limited, 2¾-3⅛; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10¾-11¼; Submarine, 260-270; Submarine Scrip, 2⅛-2¼; West Coast of America, Limited, 3-3¼; West India and Panama, Limited, 2⅛-2⅜; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6¼-6¾; Western and Brazilian, Limited, 9-9¼; Ditto, 6 per cent. Debentures "A," 106-110; Ditto, ditto, ditto, "B," 98-101; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¾-4; India Rubber Company, 17⅞-18; Ditto, 6 per cent. Debenture, 106-108.